INDEXED.

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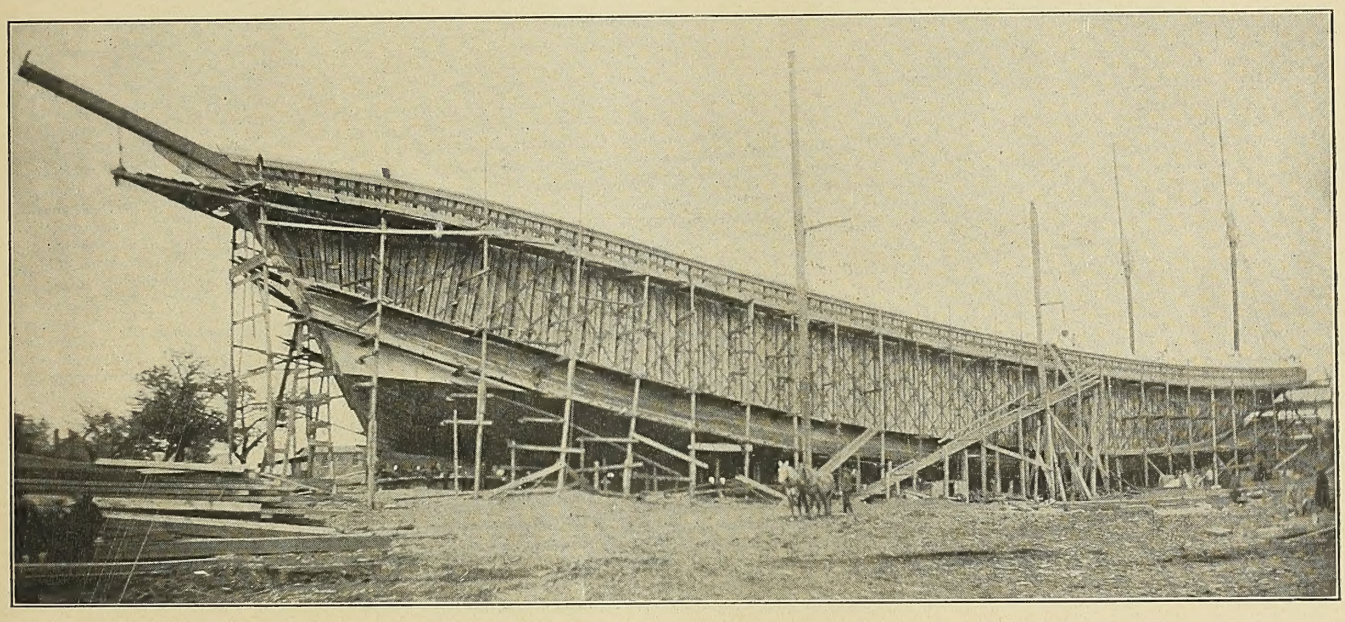
THE SIX-MASTED SCHOONER WYOMING.

Bath, Me., has demonstrated her supremacy in marine construction in many forms and on many occasions, but the product which first brought fame to the city was the wooden sailing vessel. Although in recent years some of the largest and fastest steel warships in the United States navy have been turned out from her yards, still the work of building wooden sailing vessels goes on, and each year magnificent vessels of this type sail proudly down the Kennebec to join the already large fleet of Bath-built ships engaged in the coasting trade.

The six-masted schooner *Wyoming,* launched from the yards of Percy & Small, Bath, Me., on December 15, is the crowning specimen of the original Bath product, as she is the largest wooden sailing vessel that ever floated. The *Wyoming* is 350 feet in length over all and 304 feet on the keel. She is 30 feet deep and 50 feet beam. About 1,500,000 feet of hard pine was used in the construction of the hull.



THE LARGEST WOODEN SAILING VESSEL EVER BUILT. NOTE THE DIAGONAL BRACING OF THE HULL.

The six lower masts are of Oregon pine, 126 feet long and 30 inches in diameter. They are spaced 44 feet 6 inches apart. The topmasts surmounting these are 56 feet long. The spanker boom has a length of 80 feet, the jib boom 75 feet and the bow sprit 52 feet.

The hull is ceiled with 14-inch yellow pine and planked with the same material. The frame is of Virginia white oak, molded 16 inches at the keel and tapering to 8 inches at the top; sided 14 inches. The keel is of the best of oak, in two tiers each 14 by 15 inches. As shown in the accompanying midship section, the keelson is in six tiers, each 14 by 14 inches, with sister keelsons, each four tiers deep of the same size timber.

The beams are 13 inches by 14 inches in the lower hold, the main deck beams are 11 inches by 12 inches, and the upper deck beams 9 inches by 13 inches. The ceiling in the poop is 11 inches and 14 inches. The lock strakes in the lower hold are 12 inches by 14 inches, two strakes, and the between-deck waterways are 12 inches by 14 inches two strakes The stanchions in the lower hold are 13 inches by 14 inches and between decks 11 inches by 13 inches. No hanging knees are used in the construction of the vessel. There is one shelf strake 14 inches by 14 inches in the lower hold; one shelf strake between decks 14 inches by 14 inches and one under the poop deck 14 inches by 14 inches.

The upper deck is planked with white pine 3½ inches by 4½ inches, the middle and lower decks are of 3-inch by 5-inch hard pine. The plank shear is 6 inches by 15 inches. The two lock strakes are 8 inches by 12 inches and 9 inches by 12 inches. The upper deck is in one unbroken sweep from stem to stern, with none of the depressions and enclosed areas that fill with water and become nuisances in rough weather. Furthermore, the flush deck has the merit of giving added strength.

The planking consists of three garboard strakes 8 inches by 14 inches, the remainder being 6 inches by 14 inches down to 6½ at the gunwale. The fly rail is 5½ inches by 11 inches. The outside fastening is of oak below the waterline, and of locust above the load waterline.

There are five hatches, those in the upper deck being 12 feet by 18 feet, and those in the lower decks 12 feet by 13 feet. Only galvanized iron is used on deck.

The quarters forward, as well as aft, are very commodious,

and for a merchantman even luxurious. The after house is 30 feet by 36 feet, and contains two saloons, the captain's room, the mate's room, a pantry, bathroom, chart room and medicine department. The cabins are paneled in quartered oak, mahogany and bird's-eye maple. A combination of white spruce and cypress forms a striking effect inthe overhead work. The captain's room is finished similarly to the cabins. There is a house aft of the main mast 20 feet by 28 feet containing the galley, mess room, steward's room, second mate's room and carpenter shop. The forward house is 18 feet by 28 feet and contains the engine room, the engineer's room and forecastle. The forecastle has accommodations for eight sailors.

LAUNCH OF THE SIX-MASTED SCHOONER WYOMING.

These quarters are all finished in North Carolina pine and are steam heated.

Three boats are carried by the schooner, a 26-foot ship's yawl with a 10-horsepower Kennebec engine, a 16-foot boat and a 12-foot skiff.

The hull is reinforced by a wrought iron belt strap 8 inches by ½ inch, and a system of diagonal belt strapping throughout 4 inches by ½ inch, as shown by the photograph taken during the construction. This method of strengthening has been exploited with highly favorable results during the past few years in several of the larger wooden schooners. It has proved to be the most effective means of keeping the long and otherwise flexible hulls in shape.

In competition with the invading barges and steam colliers, the *Wyoming* will spread 12,000 yards of canvas. She is equipped with a Hyde No. 13 windlass. Two Balt stockless anchors weighing 8,500 pounds each are furnished at the ends of 240 fathoms of 2¾-inch Bradley chain.

The hull is salted throughout between planking and ceiling, six hundred hogsheads being used for the purpose.

The *Wyoming* registers 3,730 gross tons, and is classed A1 for sixteen years. She will carry 6,000 tons of coal, a cargo which is equal to the capacity of eight or ten of the average three-masted coasters.

The schooner was designed by Bant Hanson, and is the splendid product of long years of experience in this line. The master builder was Miles M. Merry, who holds the tonnage record for square riggers as well as for fore and aft vessels. It was he who built the ship *Roanoke* for the Sewallc some eighteen years ago, which was the largest ship ever built of wood.

The *Wyoming* will engage in the Atlantic coasting trade under the Percy & Small flag, and under the command of Captain Angus McLeod, formerly of the five-master *Governor Brooks.*

We are indebted to the Stevens Bros., Bath, Me., for the photographs and description of this vessel.

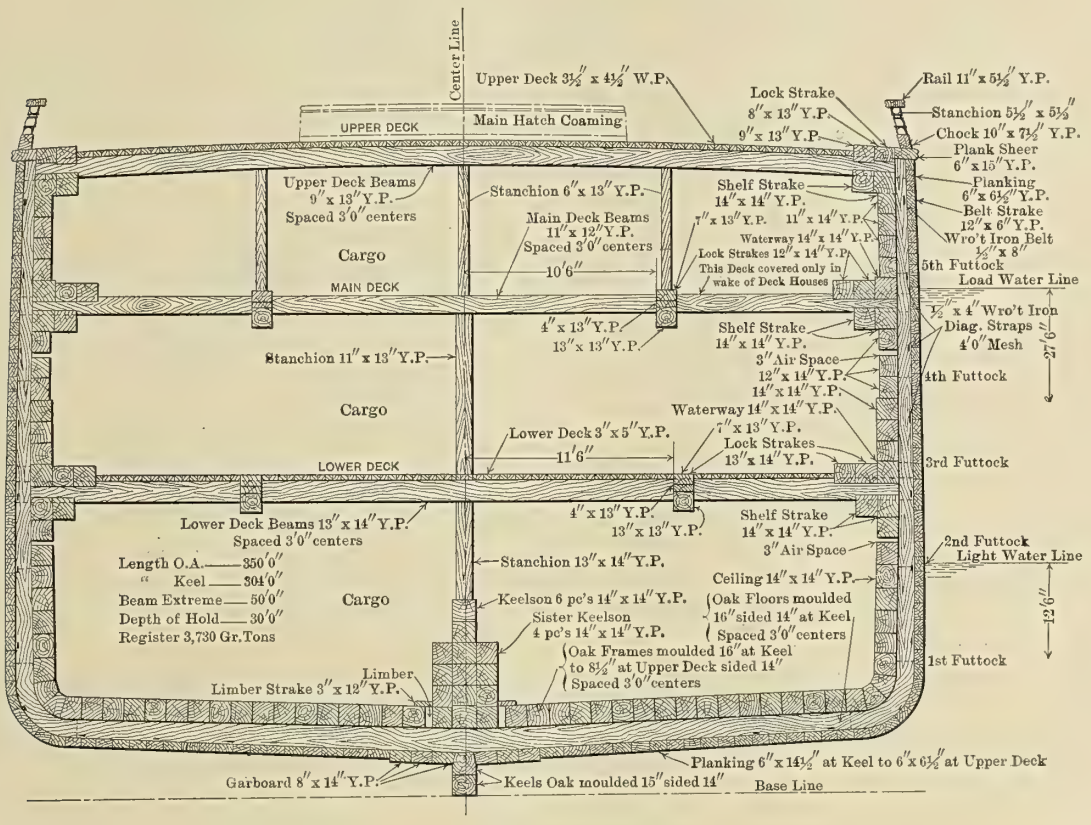
Launch of the Battleship Utah.

The fifth American Dreadnought, the battleship *Utah,* was successfully launched from the yards of the New York Shipbuilding Company, Camden, N. J., December 23. A record was established by launching the boat nine months and eight days after laying the keel. The nearest approach to this was in the construction of the *North Dakota,* which was launched in ten and three-quarters months from the date of laying the keel. The *Utah* is 551 feet 6 inches long over all and 510 feet long on the waterline. Her beam is 88 feet 2 inches, and her displacement 21,855 tons.

THE TREATMENT OF MARINE BOILERS ON LONG VOYAGES.*

BY H. RUCK-KEENE.

The boilers should always be thoroughly cleaned and all scale or deposits on the heating surface removed. A sufficient quantity of zinc plates should be securely attached by studs to the furnace sides, and also to any other part of the boilers where there is any sign of corrosive action. Clean, fresh water —and fresh water only—should be used for first filling the boiler and for make-up feed, and the feed water should be heated up to about the temperature of the boilers before it is passed into the boilers, as the use of heated feed water is sea water out of the boiler. For this the use of fresh water for the make-up feed is essential. And fresh water must either be carried in the ballast tanks, or, as is now the usual practice in most vessels running long voyages, efficient evaporators must be fitted to provide sufficient fresh water for this purpose, and they must be sufficiently large to work to the required capacity without priming. A certain amount of sea water will, however, be passed into the boilers if the condenser is leaking, whatever means may be provided for the make-up feed, but such a leak should be stopped as soon as possible. To ensure this, the condition of the feed water as it leaves the hot-well should be regularly and carefully ascertained, in order that the very first discernible leakage


Center Line
Upper Deck 3½″ x 4½″ W.P.
Main Hatch Coaming
UPPER DECK
Rail 11″x 5½″ Y.P.
Lock Strake 8″ x 13″ Y.P. 9″x 13″ Y.P.
Stanchion 5½″ x 5½″
Chock 10″x 7½″ Y.P.
Plank Sheer 6″ x 15″ Y.P.
Planking 6″x 6½″ Y.P.
Belt Strake 12″x 6″ Y.P.
Wro't Iron Belt ½″x 8″
5th Futtock
Load Water Line
Upper Deck Beams 9″x 13″ Y.P. Spaced 3′0″ centers
Stanchion 6″x 13″ Y.P.
Main Deck Beams 11″x 12″ Y.P. Spaced 3′0″ centers
10′6″
Shelf Strake 14″x 14″ Y.P.
7″x 13″ Y.P. 11″x 14″ Y.P.
Waterway 14″x 14″ Y.P.
Lock Strakes 12″x 14″ Y.P. This Deck covered only in wake of Deck Houses
Cargo
MAIN DECK
4″x 13″ Y.P. 13″x 13″ Y.P.
Shelf Strake 14″x 14″ Y.P.
3″ Air Space
12″x 14″ Y.P.
14″x 14″ Y.P.
½″ x 4″ Wro't Iron Diag. Straps 4′0″ Mesh
27′6″
4th Futtock
Stanchion 11″x 13″ Y.P.
Cargo
Waterway 14″x 14″ Y.P.
7″x 13″ Y.P.
Lock Strakes 13″x 14″ Y.P.
Lower Deck 3″x 5″ Y.P.
11′6″
3rd Futtock
LOWER DECK
4″x 13″ Y.P. 13″x 13″ Y.P.
Shelf Strake 14″x 14″ Y.P.
3″ Air Space
2nd Futtock
Light Water Line
Lower Deck Beams 13″x 14″ Y.P. Spaced 3′0″ centers
Length O.A. 350′0″
Keel 304′0″
Beam Extreme 50′0″
Depth of Hold 30′0″
Register 3,730 Gr. Tons
Stanchion 13″x 14″ Y.P.
Ceiling 14″x 14″ Y.P.
Keelson 6 pc's 14″x 14″ Y.P.
Sister Keelson 4 pc's 14″x 14″ Y.P.
Oak Floors moulded 16″ sided 14″ at Keel Spaced 3′0″ centers
Oak Frames moulded 16″ at Keel to 8½″ at Upper Deck sided 14″ Spaced 3′0″ centers
12′6″
1st Futtock
Limber
Limber Strake 3″x 12″ Y.P.
Planking 6″x 14½″ at Keel to 6″x 6½″ at Upper Deck
Garboard 8″x 14″ Y.P.
Keels Oak moulded 15″ sided 14″
Base Line

MIDSHIP SECTION OF THE WYOMING.

thought by some to increase the evaporative efficiency of the boiler, and certainly reduces the strains which must be set up when cold feed water is used. Every precaution should be taken to prevent the entry of air into the boiler along with the feed water.

Some engineers still advocate the use of a small amount of sea water when first filling the boilers, especially in new boilers, so that a slight scale may be formed on the inside of the boilers, maintaining that by such treatment corrosion is avoided. But as the formation of even a slight scale on the heating surfaces must tend not only to the overheating of these parts, but also to an increased expenditure of coal in proportion to the water evaporated, it is questionable whether this is a good practice.

Especial care must be taken during the voyage to keep all of sea water should be known and promptly dealt with. These remarks also apply to the condensers of refrigerating or other auxiliary machinery using steam from the main boilers. In no case should the density of the water be allowed to exceed 1.09 or 3/32.

The question as to how often the water in the boilers should be changed must depend on circumstances, chiefly on how the density of the water has been kept. On long ocean voyages it may be impossible to make any examinations, but it may sometimes be possible to change the water in part of the boilers at coaling ports, even although the stay in port is short.

To avoid unnecessary risks it is advisable to change the water frequently and examine the interior of the boilers, more especially in the case of new boilers.

In some vessels running out to China and Japan, whose boilers I at one time surveyed annually and often at intervals of six or seven months, the water was regularly changed only at the end of voyage out or home, say after about fifty days'

* From a paper read before the Institute of Marine Engineers, September, 1909.

steaming. And though these boilers were from six to eight years old, they had never required the use of a boiler maker for repairs, nor had a scaling hammer ever been used in them, brushing and washing down being all they required when opened out. These boilers were worked under natural draft and were amply large for their work, and consequently were never forced. Fresh water was always used in filling them, and great care taken to prevent any air in solution being pumped into the boilers. All feed water was heated by means of feed heaters, and also passed through filters, and ample evaporators were fitted for feed make-up, zinc plates being also used to prevent corrosion, of which I may add there was no sign.

Other boilers which I have examined and found to be in good condition are continuously under steam for about forty-two days at a time before the water is changed. Others I believe run for twice that time without changing the water, with satisfactory results, but, generally speaking, for vessels running for such long-distance voyages as to Japan, Australia or New Zealand, even when the density has not exceeded 3/32, it appears advisable to change the water at each end of the voyage.

Great care should be taken at all times, more especially when raising steam, to prevent quick variations of temperature and consequent strains being set up in boilers, as these are often the cause of leaky seams, and of the cracking of the furnace saddle plates and combustion chamber plating. To avoid such strains, at least twelve hours, and better still, twenty-four hours, should be allowed for raising steam in the boilers.

Some engineers prefer to light all the fires at once when commencing to raise steam, others light the wing fires only, and others again light only the center fire. The first plan appears to me to be the best method, as by so doing the heat, being gradually generated in all the furnaces alike, enables the boiler to expand more equally. During this process of raising steam the water in the boiler must be kept in circulation, so as to obtain, as far as possible, an equal temperature of water throughout the boiler. There are many methods of effecting this, one of the simplest and most effective being by pumping the water from the bottom of the boiler and delivering it back into the boiler through the feed pipes, having first heated it in the feed heater by steam from an auxiliary boiler.

There does not appear to be a concurrence of opinion as to the best position in the boiler for the feed water to be delivered, but in every case care should be taken that the incoming feed water does not impinge directly on the plating or tubes, for should there be any air in the feed water, acute corrosion will probably be set up on that part of the boiler against which it impinges. Probably the best position is as near the surface of the water as possible, so that any air which may be in the feed finds its way directly into the steam space.

The best hydrocarbon oils only, of a high specific gravity and high vaporizing point, should be used for the internal lubrication of the cylinders and slide valves, and the amount used should be reduced to the minimum possible. It is now generally found that the swabbing of the piston and slide rods is sufficient for internal lubrication, except in new engines or in some cases where the working surface of the valves is limited, or where a cylinder has been bored out, or a slide valve planed up and not yet worked up to good surfaces.

When electric light engines or fan engines are fitted and their crankshafts are run in oil baths, extra precautions must be taken to prevent an excess of oil being splashed on to the piston and slide rods, as trouble has often occurred through oil getting into the boilers through this cause. Even when internal lubrication is reduced to a minimum every possible means should be taken to prevent oil entering the boilers, and feed filters are now generally fitted for this purpose.

When forced draft is employed care should be taken to prevent an excessive air pressure in the ash-pits and furnaces. This is often due to the speed of the fan not being reduced when the air valves are closed on one or more of the furnaces, when cleaning fires. Keeping the fire-bars well and uniformly covered and the bridges intact are also important points, not only in preventing extra strains being set up in the boilers, but also in ensuring that the air supply is evenly distributed to the whole of the fire on the grate, thus ensuring a more perfect and economical combustion of the fuel.

At the end of a voyage the fires should be allowed to die out in place, and the boilers allowed to cool down gradually, say for about twelve hours, with dampers shut, to prevent any undue strains being set up, due to rapid cooling of certain parts of the boilers.

The blow-down cocks should only be opened for a few seconds to see that they are in working order. After the boilers have been cooled down they should be pumped out and thoroughly cleaned.

THE DESIGN OF REVERSING ENGINES.

BY EDWARD M. BRAGG, S. B.

CALCULATIONS.

In the chapter on "Marine Engine Design" the calculations were carried through for an engine working under the following conditions:

Indicated horsepower = 3,000.

Piston speed = 850 feet per minute.

Boiler pressure = 185 pounds gage.

Cylinder sizes and stroke, 23½ inches, 41 inches, 64 inches by 42 inches.

Eccentricity, 4.25 inches on the high and intermediate-pressure cylinders; 4.75 inches on the low-pressure.

The reversing engine was placed between the low-pressure and intermediate-pressure gears, and the twisting moment from the low-pressure gear was 210,000 inch pounds. This was obtained by taking into consideration the weight, inertia and friction of the low-pressure valves. It was assumed that if the engine were in such a position that the maximum power had to be exerted to reverse the low-pressure gear the other two gears would be in a better position, and only the same amount of power would be necessary to reverse both the high-pressure and medium-pressure gears.

The twisting moment that the reverse engine cylinder must exert will then be 420,000 inch pounds. We will take the stroke of the engine to be

$$2.5 \times 8.5 = 21.25;\ \text{use } 21 \text{ inches.}$$

Since the reverse levers were designed to move through an angle of 75 degrees, the length of the reversing engine lever will be, by formula (1):

$$l = \frac{21}{2 \times .61} = 17.2;\ \text{use } 17.25 \text{ inches.}$$

$$\frac{420{,}000}{17.25} = 24{,}350 \text{ pounds,}$$

the force that must act upon the pin of the reversing engine lever. Assume the back pressure in the cylinder to be 10 pounds absolute:

$$200 \times .9 - 10 = 170 \text{ pounds per square inch.}$$

$$\frac{24{,}350}{170} = 143.3 \text{ square inches} = \text{area of piston.}$$

A diameter of 13.53 inches will give this area; use a 14-inch

cylinder. The reversing engine will be 14 inches by 21 inches. Since the diameter of the low-pressure cylinder is 64 inches this makes the cylinder of the reversing engine .219 times the low-pressure diameter.

PISTON ROD.

The length of rod will be about 21 + 14 = 35 inches.

By formula (2):

$$F = \frac{2 \times 24{,}350}{\pi \times 4{,}000} = 3.88$$

$$D^2 = \sqrt{\frac{.48 \times 3.88 \times 60{,}000 \times 35^2}{10{,}000{,}000}} + 15.05 + 3.88$$

$D = 3.04$; use 3 inches.

CONNECTING ROD.

Since no oil cylinder is to be used on this gear the length of the connecting rod can be about

$17.25 \times 2.5 = 43.4$; use 42 inches.

By formula (3):

$$F = \frac{2 \times 24{,}350}{\pi \times 5{,}000} = 3.1$$

$$D^2 = \sqrt{\frac{1.08 \times 3.1 \times 60{,}000 \times 42^2}{10{,}000{,}000}} + 9.6 + 3.1$$

$D = 3.14$; use 3.25 inches.

Diameter at ends $= 3.25 \times .85 = 2.76$; use 2.75 inches.

CROSSHEAD GUIDE.

By formula (4):

$$w = \frac{17.25 - \sqrt{17.25^2 - 10.5^2}}{2 \times 42} \times 24{,}350 = 1{,}030 \text{ pounds.}$$

The length of guide from center to center of supports will be about the same as the length of the piston rod.

$$M = \frac{W l}{4} = \frac{1{,}030 \times 35}{4} = 9{,}000$$

For a beam of round section $D = \sqrt[3]{\frac{M \ 10.2}{f}}$

$$D = \sqrt[3]{\frac{9{,}000 \times 10.2}{5{,}000}} = 2.64$$; use 2.75 inches diameter.

$$\text{Length of slipper} = \frac{1{,}030}{2.75 \times 70} = 5.36$$; use 5.5 inches.

$$\text{Surface of crosshead pin} = \frac{24{,}350}{3{,}000} = 8.12 \text{ square inches.}$$

Length of bearing surface of pin = diameter of connecting rod at upper end = 2.75 inches:

$$\frac{8.12}{2.75} = 2.95$$; use 3 inches diameter.

If the All-round type of gear is used the proportions will be as given below. Assume r to be 19 inches.

From formula (10):

$$p = \sqrt{\frac{6.3 \times 420{,}000 \times 10.5}{4{,}000 \times 2 \times 17.25 \times 19}} = 3.22$$; use 3.25 inches.

$$n = \frac{2 \pi 10}{3.25} = 36.7$$; use 37 inches.

$$r = \frac{37 \times 3.25}{2 \pi} = 19.15 \text{ inches.}$$

We will use steam at boiler pressure for the engine, and assume the *m. e. p.* to be .8 the absolute pressure; *m. e. p.* = $200 \times .8 = 160$ pounds.

From formula (6):

$$d^2 s = \frac{4 \times 420{,}000 \times 10.5}{17.25 \times 160 \times 37 \times .4 \times .8} = 540$$

Let $s = 6$ inches, $d^2 = 90$ inches. Use two cylinders 6.75 inches diameter by 6-inch stroke.

The proportions of the worm, worm wheel and shaft can be found in the same way as those for the turning engine. The length of the connecting rod will be determined by the position of the worm wheel. The size of the connecting rod and of the pins can be determined by the rules already given.

SOME SPECIAL MACHINE TOOLS USED IN SHIP CONSTRUCTION.

BY E. C. AMOS, M. I. MECH. E.

It is not proposed in this brief article to attempt to deal with all the machinery used in ship construction, but to describe and illustrate a few of the latest types of machine tools used in modern ship work and in the construction of marine reciprocating engines and turbines. Specialization has now become so general that it is difficult to find any machine tool to-day that does not claim to be special, and consequently the old terms of lathe, planer, drill, etc., cease to carry any real meaning unless prefixed by one or more adjectives to define their special features. Instead of demanding an infinite variety of work from one machine we are to-day using an infinite variety of machines, each of which performs one operation on the same piece of work. This is expressing the situation in an exaggerated way, but it is approximately true.

One of the most important operations in a dockyard is the formation of the frames to which the plates are riveted. Frames have to be bent in a variety of curves, while those at the bow and stern must also to be splayed and closed. Many of the curves are parabolic and irregular, and hand-work still enters very largely into the process. There yet remains to be designed a machine which will cold-bend to any curve without waste and will at the same time "open bevel" and "close bevel." It is a difficult requirement to meet, but the writer believes that the great need of such a machine will in time produce it.

BEVELING MACHINE.

For the purpose of beveling only, however, there are machines such as the Davis beveling machine, Fig. 1. This machine will deal with angle-bars up to 7 inches by 5 inches by 9/16 inch thick; or, provided the narrow flange is always the standing flange as the bar passes through the machine, it will bevel angle-bars up to 9 inches by 5 inches by 9/16 inch. It will also treat zee sections 6 to 8 inches broad by 4 inches deep, and channel sections 6 inches by 3 inches by 9/16 inch to 8 inches by 4 inches by 9/16 inch; also certain sizes of bulb angles and zee bars to any required angle from 90 to 135 degrees, and shut bevel from 90 to 60 degrees. It will bevel channel sections to about 30 degrees from the square.

It is hardly necessary to elaborate on the advantages of such a machine over hand labor for the purposes named. The actual results obtained show a saving of at least 50 percent over hand labor. In the first place, there is no guessing at the angle, as the machine can be correctly set for this, and since its action is positive the work can be carried out in one heat. With hand beveling several heats are generally necessary, and consequently the metal becomes brittle, the flanges hollow and the edges unfair, even if the material does not become burnt, which is often the case. This machine draws the bar out of the furnace and effects the beveling when the bar is at its best

heat. Moreover, since the work is done in rollers when it is hot the edges of the bar remain clean while the rough edges of the rivet holes are smoothed down.

For frame and other work to be done by the machine, the bevels are taken from the body plan of the ship at regular intervals along the bar, the spot numbered; as usual, the angle at each number or spot is measured, and the numbers transferred to the corresponding angles on the bevel board. On the machine is what is termed the bevel index, which is graduated in degrees from 90 to 45. The angles which have been marked on the bevel board are then indicated by their numbers on the bevel index of the machine, in their relative positions, measuring from the end of the bar.

when the feed levers on the saddle come into contact with the stops, thus enabling the machine to be stopped or started by hand in either direction without putting on the feed. The reversing mechanism is operated from a platform placed at the back of the cross-arm by a lever having a sector on the lower portion of it, which gears with a pinion on the square reversing shaft. On the end of this square shaft is another pinion, which gears with a sector and lever connected to a plate which has scroll slots cut in it to receive rollers on the belt forks. There are two belts for driving the machine when on the cutting stroke and two for the return stroke, to obviate the use of wide belts, which are not easily moved from one pulley to the other.

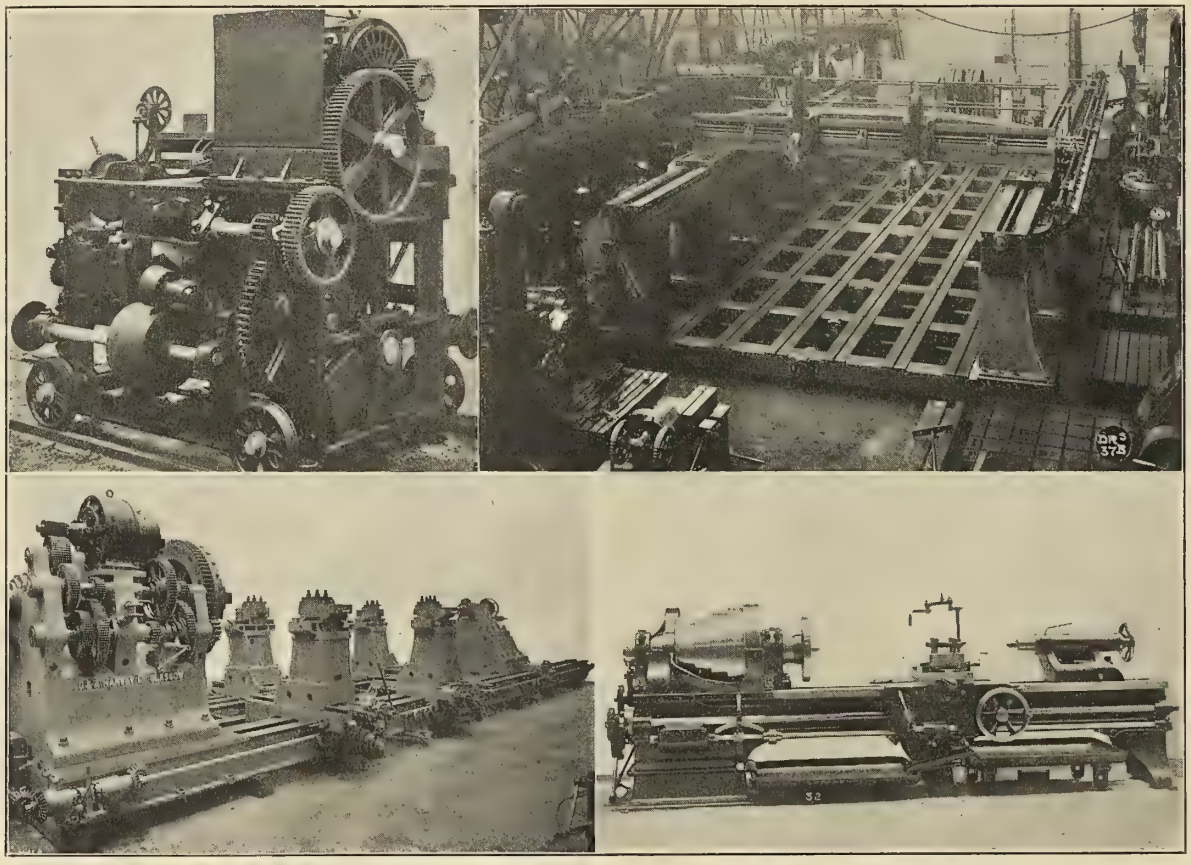


FIG. 1.—DAVIS BEVELING MACHINE.
FIG. 2.—LARGE TURBINE PLANER.
FIG. 3.—LATHE FOR TURNING TURBINE ROTORS.
FIG. 4.—HIGH-SPEED REDMAN LATHE.

TURBINE PLANING MACHINE.

Fig. 2 shows a large turbine planing machine capable of planing across the top of the work 14 feet wide and down the sides of work 12 feet wide, and capable of receiving work under the tools 7 feet deep by 30 feet long. The machine consists of two beds, each 36 feet 9 inches long, having a sliding saddle, in which is mounted a cross-arm or slide. These beds are of heavy section, the distance between them being 14 feet 2 inches. They are supported by legs, which rest on a heavy girder base-plate 20 feet wide by 12 inches deep, extending the entire length of the machine. The cross-arm is driven backwards and forwards by pulleys and bevel gears, which actuate two 4-inch steel screws in the beds and give a cutting stroke of 35 feet per minute in either direction. On the cross-arm are mounted two tool slides carrying the tool rams, which can be swiveled to any angle, and which have a down-feed of 30 inches in all positions.

The reversing mechanism to the cross-arm is quite independent of the feed arrangement, and the feed is only put on

Along the side of the bed is a rail, which carries the feed and reversing stops and sliding bearings for the square feed and reversing shafts. These bearings are pushed along the rail by the saddle, and are so arranged that the shafts are always supported about half-way when the saddles are at the ends of the beds. The feed is operated by stops secured to the rail along the side of the bed, which, coming in contact with the feed levers, bring the clutch on the square shaft into gear, causing the feed disc to revolve, and through the feed levers move the feed pawl either forward or backward, according to the direction in which the cross-arm is traveling.

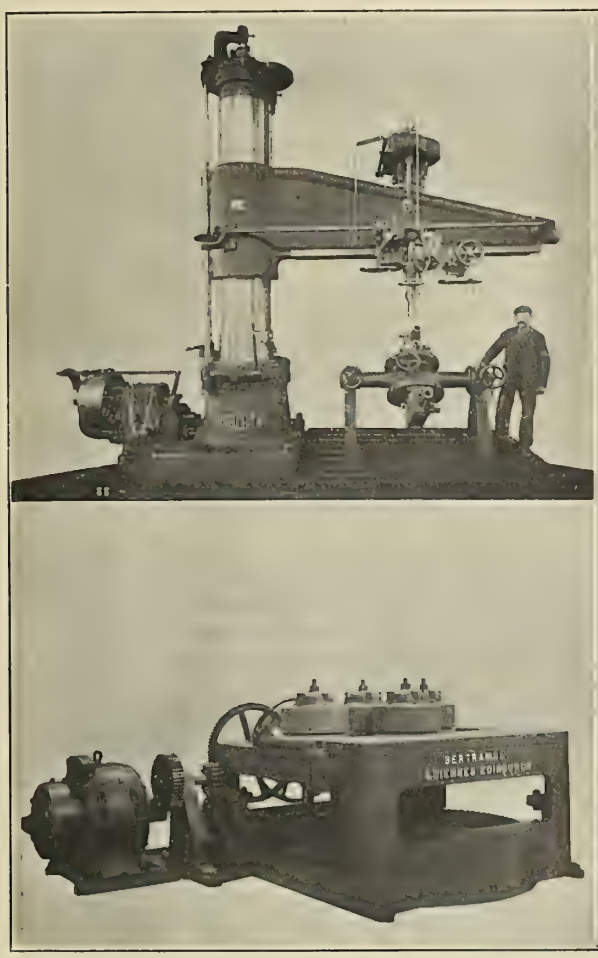
The feed mechanism is so arranged that the feed can be put on either at the cutting end of the stroke or at the return end, or at both ends. The feed is varied by means of a plate at the side of the feed gear and a catch piece fixed to the feed pawl. To obtain the maximum feed, the plate is turned, by means of a thumb wheel and pinion, to such a position that the recessed part of the plate occupies the arc made by the feed pawl, and the catch piece is therefore not affected by the plate, as the

pawl is in gear from the commencement of its stroke. To shorten the feed the plate is placed in such a position that the catch piece which is attached to the feed pawl rides on the top of the feed plate until it comes opposite the recessed portion, when it allows the pawl to drop into gear and put on the feed. The maximum feed is 1 inch and the minimum feed 1/24 inch. For broad cutting, which, of course, is done with the machine cutting in one direction only, a feed up to 2 inches can be obtained.

The total weight of the machine is 75 tons, and it is adapted for taking heavy cuts running at high speeds.

for the following purposes: The turning of steel stanchions with end flanges, the turning of launch and winch crankshafts, piston rods where forged solid with cross-head, connecting rods with open-type crank ends and Y-shaped cross-head ends. Forged work of this kind is generally very rough, and this type of lathe will be found to remove the maximum quantity of material with general handiness in working.

The quick changing of direction of feeds is a special feature of this machine. The fast headstock is powerfully geared; the large gear wheel being 24 inches diameter, as is also the largest cone. The spindle bearings are also of very ample propor-



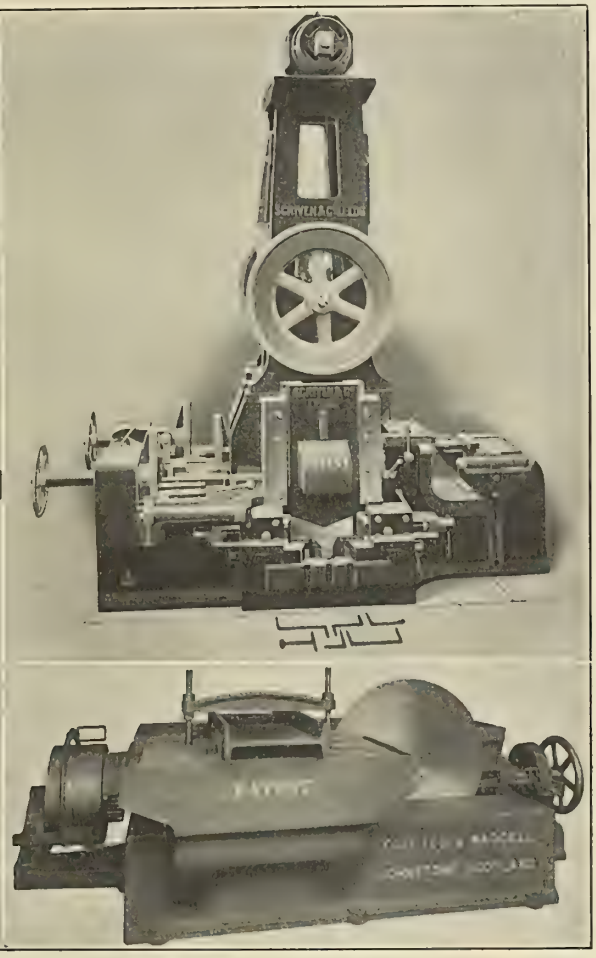


FIG. 5.—ASQUITH RADIAL DRILL.
FIG. 7.—VERTICAL ANGLE BENDER.

FIG. 6.—PUNCHING AND SHEARING MACHINE FOR SPECIAL SHAPES.
FIG. 8.—COLD SAWING MACHINE.

LATHES FOR SPECIAL PURPOSES.

Fig. 3 shows another powerful machine also used in turbine construction. This lathe has been specially designed for turning large turbine rotors and for tipping the blades of same. It weighs 165 tons and will admit 15 feet diameter over the bed by 50 feet between the centers. When driven by a variable speed motor giving eight changes of speed, it is possible to obtain thirty-two changes of speed on the lathe spindle, as the headstock is quadruple geared. The double bed is provided with two front and two back independent saddles, having compound-swiveling slides. The machine is designed for screw cutting, and will also cut long and short tapers. While this machine is specially suited for turbine work it can also be usefully employed for turning heavy shafting, surfacing and screw cutting for general purposes.

A lathe of smaller dimensions, but one equally important in a machine shop, is the 10½-inch center high-speed Redman lathe. (Fig. 4.) This tool represents the most recent model of a high-grade hollow spindle lathe, and is specially adapted tions, being 5½ inches diameter by 7¼ inches and 5½ inches long, respectively. The lathe will cut right and left-hand threads. All gears and racks are machine-cut from the solid, and are of steel throughout except headstock gears, which are of cast iron, and the worm wheels, which are of phosphor bronze. The feed shaft is positively driven by six speed, quick-change gears, operated (without stopping the lathe) by a handle in front of the fast headstock. This gives ten to forty cuts per inch.

With a 12-foot bed, admitting 5 feet 6 inches between centers, this lathe weighs 4 tons.

CENTRAL THRUST HEAVY-TYPE RADIAL DRILL.

In all marine shops drilling machines play a very important part. A great many types of machines are used, but it will only be possible to describe one class, viz.: a radial. The machine selected, the Asquith radial (Fig. 5), has a very wide range of work, including drilling, boring, tapping and studding. The spindle slide is mounted upon the arm in such a way that

the thrust is taken on two slides formed in the underside of the radial arm. The construction of this arm is designed to eliminate all twisting strains and to give the greatest efficiency to the machine. The portion of the arm in which the spindle slide works is of the box-girder type, the walls of which are strongly ribbed to resist lifting stresses. The spindle works in the middle of the box-girder, thus ensuring a central thrust and a large bearing surface for the slides.

The machine shown has a radius of spindle ranging from 9 feet maximum to 2 feet 10 inches minimum, and will admit work under the spindle nose from a maximum of 8 feet down to a minimum of 3 feet 9 inches, the arm having a vertical adjustment in the column of 4 feet 3 inches. The spindle is 3¼ inches diameter in the driving part, and has a vertical adjustment by hand and self-acting mechanism of 1 foot 8 inches. It is made of high carbon steel, accurately ground and balanced. The thrust is taken by ball bearings. Double gears are fitted on the spindle slide, which can be instantly engaged or disengaged by lever at front without stopping the machine. The spindle is fitted with clutch motion, which enables it to be instantly stopped, started or reversed without using belt motion for tapping and inserting studs, changing drills, etc. Also the tap can be reversed at a higher speed.

Variable self-acting feed motion is obtained by gears which enable variations to be made instantly while the machine is running, by simply moving levers. The hand-feed has a fine adjustment. An automatic trip motion enables varying depths to be drilled, with safety stop to prevent over-traverse.

The arm is fitted with a fine radius motion, which allows of its being accurately radiused from the workman's position without having to push it over from the end. This gear can be thrown out when more rapid movement of arm is desired. The arm is fitted with hand and power motions for raising and lowering, and can be locked firmly in any position. Varying spindle speeds are obtained by means of an improved type of gear box fixed on the base of the machine.

The machine has a massive baseplate, 14 feet 9 inches long by 6 feet wide by 1 foot deep, and weighs about 18 tons.

PUNCHING, SHEARING AND BENDING MACHINE.

In view of the now prevalent use of bulb tees and angles in ship construction special punching and shearing machinery must be provided for these sections. The machine illustrated by Fig. 6, embodying several of Messrs. Scriven & Company's patents, is designed to perform quite a number of operations, which may be briefly described as follows:

The patent section shears seen in the center of the machine will cut any section of zee, channel, tee or angle from 6 inches to 15 inches wide, either right or left hand, with square or bevel ends and without changing a knife or distorting the section. The bar is supported by knives on four adjustable horizontal slides, and the shearing is effected at one stroke by a knife attached to a vertical slide fitted with independent stop motion.

At one end of the machine is a combined beam bender and bulb shears, where beams, etc., up to 15 inches deep can be cambered or straightened by a reciprocating ram and two adjusting screws. Between the screws is placed the horizontal bulb shears, with independent stop motion, for cutting off one side of a bulb to prepare a beam for receiving knees, etc., or for notching the leg of the zee, channel, tee or angle-bar.

At the other end of the machine is a horizontal twin punch, having two slides, each with independent stop motion, so that two sizes of holes can be punched in a beam or bar at one handling. The die holder is of special design, to enable holes to be punched in the webs or flanges of channels, etc. A vertical punch, on the cam and lever principle, can be placed at this end instead of the horizontal punch when desired.

VERTICAL ANGLE AND TEE-IRON BENDING MACHINE.

Fig. 7 illustrates one of the latest types of this class of machine that has only recently been put into service in a leading marine shop on the Tyne. This machine will bend angles, tees and flat bars in rings suitable for furnace rings or other purposes. It consists of a heavy cast iron table or bench, above which project four rollers, and by means of which the rings to be formed have the flanges resting on the top of the bench. Each of the rollers is made in two pieces, and so designed that the top part may be raised or lowered, thus forming suitable grooves to suit the varying thickness of sections being handled. The two center rollers are the gripping and driving rollers, being geared together by specially designed spur pinions, allowing for the necessary adjustments of centers for various thicknesses. The front roller is driven through spur and bevel gearing from a first-motion shaft, which in the machine illustrated is connected through machine-cut gearing from the motor spindle. The two side rollers are the bending rollers, and are carried in heavy slide blocks, which are traversed in suitable recesses in the bench by means of mild steel screws and a spur gear by a hand-wheel at the back of the machine, thus bending the material into circles round the front driving roller. The back center roller is adjusted to grip the bars by a hand-wheel at the back of the machine. Suitable carrying brackets and rollers are provided at the sides of the machine to support the rings while being bent.

When it is desired to bend tees into rings, having the center flange lying in the same plane as the ring, it is only necessary to remove a plate fitted to the top of the table, and which remains in position while the angles are being bent.

HYDRAULIC FORGING PRESS.

In the production of heavy forgings the hydraulic forging press has largely supplanted the steam hammer, since not only is the work produced far superior but it is effected at less

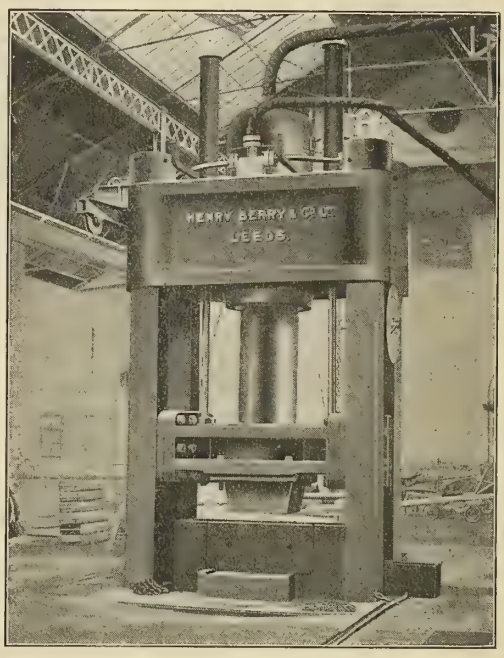


FIG. 9.—HYDRAULIC FORGING PRESS.

cost. The steam hammer also requires a skilled operator to manipulate it, whereas this press can be operated by unskilled labor.

In Fig. 9 is seen a very fine example of a heavy forging press on Berry's system. The advantage of this system consists in working the press from a low-pressure accumulator

supply, which is also available for working the lifting cylinders of the forging cranes, auxiliary appliances, etc. This low pressure is utilized in bringing the ram down to the forging, when it is then automatically intensified or increased to the maximum pressure.

COLD-SAWING MACHINE.

It will be readily understood that in all shipyards a great deal of material must be cut to dead lengths. For this purpose a cold-sawing machine is used. A standard type of this machine, possessing a number of improvements, for dealing with heavy work up to 10½ inches deep, the saw having a travel of 42 inches, is shown in Fig. 8. The work to be treated is stationary, while the rotating saw traverses through the work with a self-acting motion, and by merely moving a hand lever the saw is rapidly withdrawn ready for another cut. Automatic stops prevent overrunning in either direction. The tables are provided with tee slots, the main table being 7 feet by 2 feet 6 inches, and the side table 4 feet by 2 feet 6 inches.

The saw is 36 inches diameter, and is made of special quality hardened steel mounted on an improved flange. The saw spindle is of hard steel revolving in long, parallel bearings of phosphor bronze, which are adjustable for wear, and is driven by a phosphor bronze wheel and hardened steel worm running in a continuous oil bath.

The self-acting feed motion is variable up to 2 inches traverse per minute, and is arranged to adjust itself automatically to the section being cut, a small section being cut through rapidly and a large section correspondingly slower without any attention by the attendant.

The soapy water used as a lubricant is carried in a trough, in which the saw revolves.

PORTABLE PNEUMATIC TOOLS.

During the last ten years or so an entirely new class of labor-saving device has entered into ship construction, viz.: portable pneumatic tools. The author of this article was closely associated with the first plant installed at His Majesty's Dockyards, and can testify to the great amount of time saved in the alterations carried out on H. M. S. *Revenge* just prior to the naval demonstration at Spithead at the time of the Coronation. Since then their application to ship construction has been very rapid, and to-day no dockyard, or, indeed, private yard of any standing, can afford to be without them.

The principal tools used are riveters, drills and hammers, with a considerable variety of each type, but anything like an adequate description of their construction and application would unduly lengthen this article. It may be said, however, that they have proved themselves to be real labor-savers, and show an immense saving over hand work. Prior to their introduction work that could not be taken to a machine had to be done by hand. To-day the portable pneumatic tool is taken to the work, and not only does work previously done by hand (ratchet-brace, hand riveting, hand chipping and so forth), but it is found that in many cases it is more economical to carry the work out "in situ" by means of the pneumatic drill instead of pulling it under a fixed drilling machine. This is specially the case where several plates, etc., have to be riveted together. An immense amount of data is now at the disposal of those seeking it in regard to the saving effected over hand labor, but it may be interesting to note that as far back as 1900, in a paper read before the Institution of Mechanical Engineers, London, by the writer of this article, a table of actual results showed the great saving effected. A brief extract is given below.

Since that date the tools have been considerably improved and the men have become more skillful in their use.

When comparing the cost of pneumatic tools and hand labor it is necessary to take into consideration two points:

(1) That with the same-sized shop and practically the same standing charges a great deal more work can be turned out in the same time.

(2) That with hand labor, especially in riveting, calking and plate drilling, work can only proceed at a comparatively slow rate, however many men may be employed and however closely they work.

The cost of producing compressed air and the upkeep of the machines has also, of course, to be considered. But actual experience has shown that so long as the machines are kept in proper working order and are properly treated the saving over hand labor is very considerable.

Space does not permit of more than this brief reference to what is a very important class of machines. Fig. 10 shows an individual machine, viz.: a deck riveter, specially designed for riveting ships' decks and for bridge work. On the little carriage is mounted a Boyer riveting hammer, the weight of the holder and frame assisting the workman in keeping the riveter up to its work.

There has been a good deal of discussion and some difference of opinion expressed as to the relative values of hand and

Type of Tool.	Nature of Work Done and Time Taken.	Remarks.	Authority.
Hammer.	Calking.	In a general way, calking tools will do as much work as five or six men with ordinary tools, and the work is better done.	Alex. Stephen & Sons, Glasgow.
Hammer.	Calking.	Sixty percent cheaper than hand calking and quite as efficient. The plates are punished less, and on this account pneumatic calking is particularly useful for light plate work, such as tenders and tanks.	Mr. James Holden, Great Eastern Railway Works, Stratford.
Hammer.	For cutting off thin steel plates they have proved very satisfactory, and the work is done in one-quarter of the time taken for punching and shearing.		Ditto.
Drill.	Drilling boilers.	Very ingenious and useful tool. Can be used anywhere, even through a boiler manhole. Does its work quite as quickly as any radial or other drilling machine, being much quicker than if done by hand.	Clayton, Sons & Co., Hunslet, Leeds.
Drill.	As used for drilling work in place a ⅞-inch diameter hole can be drilled through ½-inch plate in 22 seconds.	This compares by 4 minutes with a flexible shaft, and 10 minutes with a ratchet brace.	Mr. James Holden, Great Eastern Railway Works, Stratford.

pneumatic riveting. The fact remains, however, that a pneumatically-closed rivet requires to be longer, thus showing that the hole is better filled when a pneumatic riveter is used than when a rivet is hand-driven. Not only this, but the work is completed when the rivet is at its proper heat.

In concluding this article the writer is conscious of having omitted reference to a great many important machines, but the space permitted did not allow of further details. A few words as to the future of shipbuilding may not be out of place here, since a great change in ship construction must necessarily

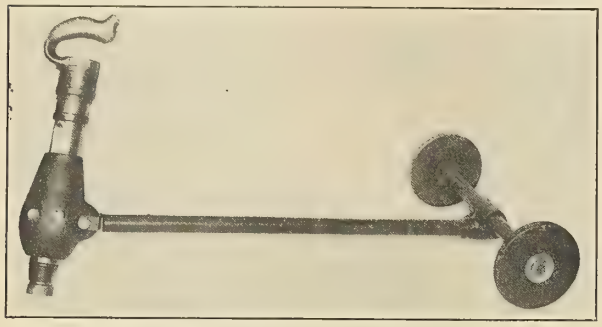


FIG. 10.—PNEUMATIC DECK RIVETER.

affect the machine tools employed. In view of the great developments made in internal combustion engines, it is not unlikely that they will in the near future enter largely into the propulsion of ships. This in itself will effect considerable changes in the marine shop. About 100 years ago all ships were built of timber, what will they be built of 100 years hence? It is generally acknowledged that with our present form of motive power, section of hull and method of construction, we have nearly reached the limit of speed possible under these conditions. It is safe, however, to prophesy that this is not the limit at which we shall travel on the sea in the future. Consequently, we must either find a motor which shall be lighter in relation to its power or discover a new metal, or alter our hulls both in design and structure. Probably there will be changes in each of these directions, and this will doubtless entail alteration in the design of the machine tools employed. It is obvious, therefore, that for the greatest efficiency shipyards and marine engine shops must be equipped with the latest machines, and they must be maintained in the highest state of efficiency.

THE SWEDISH TRAIN FERRY DROTTNING VICTORIA.

BY F. C. COLEMAN.

The *Drottning Victoria,* one of the four train ferries built for the new joint service, which was commenced early in July by the German and Swedish Governments for operation over the 65 miles of open Baltic Sea between Sassnitz and Trelleborg, represents one of the most interesting types of steamship which has been constructed during recent months. Not only is the *Drottning Victoria* a train ferry, but she has passenger accommodation scarcely inferior to that of the best transatlantic steamships, and ranks as the most representative example of a railway car ferry which has yet been built. She is 370 feet in length over all, 53 feet 6 inches in width over all, and has a draft, loaded, of 16 feet 6 inches. The dead-weight capacity is 600 tons, and the displacement 4,270 tons. The design was by William Hök, of Stockholm, and by the provision of deep bilge keels any rolling tendencies have been considerably minimized.

The *Drottning Victoria* has four decks, and the trains are shipped on a special track 'tween decks on two parallel lines laid to the standard Swedish and German State Railways' gage of 1.435 metres. The total effective length of the two tracks is 590 feet, and they will accommodate about ten heavy bogie corridor sleeping carriages. On the car deck the vehicles are secured by screws attached to gun-metal shackle plates, and during heavy seas there is provision for a further screw attachment from the top of the cars to the fore and aft girders of the main structure of the vessel.

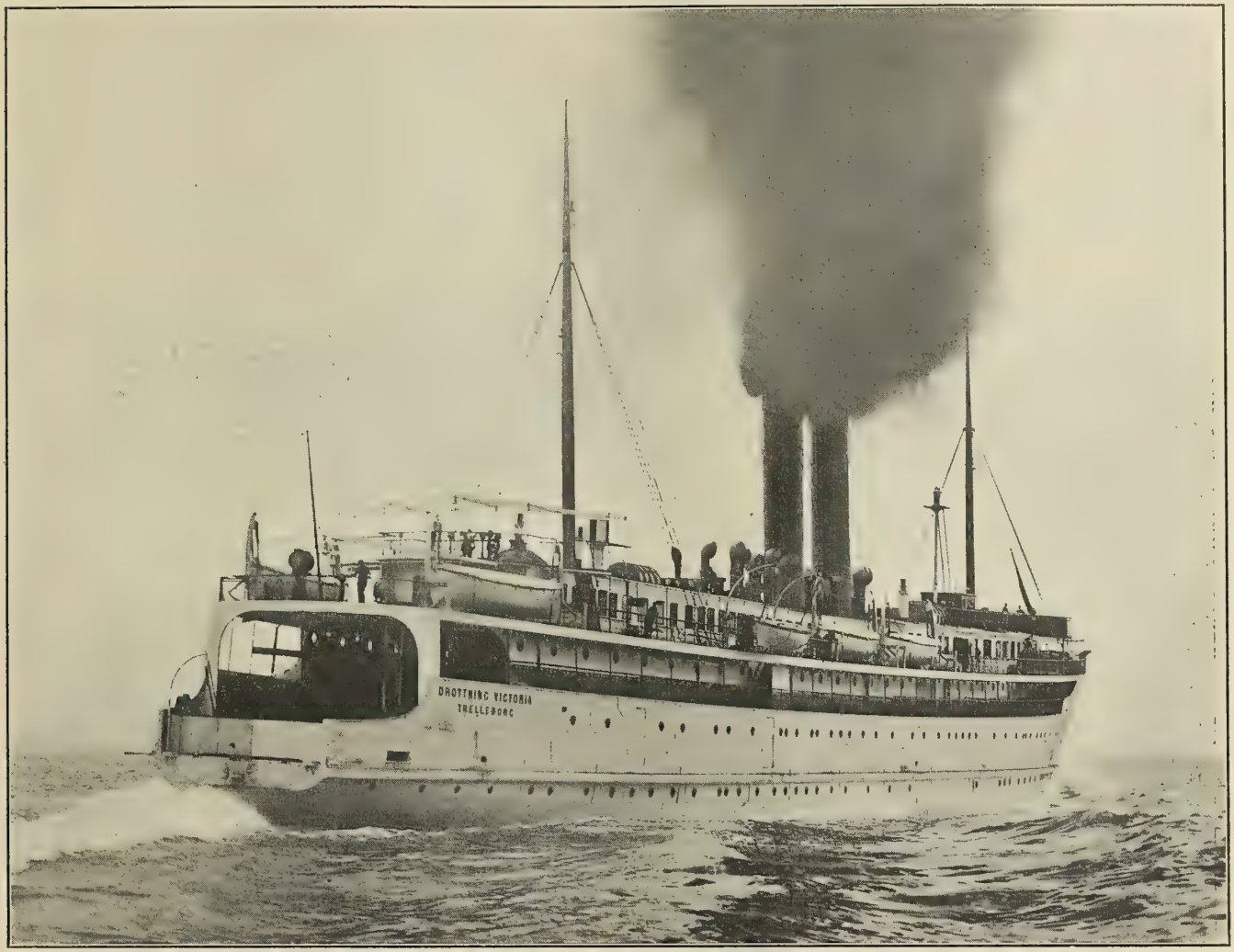
The main machinery, built at the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd., consists of twin-screw triple-expansion engines, with four boilers 16 feet 4 inches diameter and 12 feet long working under Howden's forced draft. The engines are 23½ inches, 38½ inches and 63 inches diameter and 36-inch stroke, and they work at 185 pounds pressure.

During embarking and disembarking of the vehicles on the car deck, complete steadiness of the ship is secured by a system of trimming tanks, one being fitted on each side of the vessel abreast of the boilers. These tanks have each a maximum capacity of 88 tons, and there is provided in connection with them two 15-inch centrifugal pumps.

The first class sleeping accommodation is reached by means of stairways from the car deck and is situated aft of the machinery space. The third class accommodation, also reached from the car deck, is situated forward of the boiler space. On the port side is an apartment affording accommodation for twenty-two passengers. A similar apartment is situated on the starboard side of the ship, and between these is the third class dining saloon, and, at the aft end, there is a corridor leading to pantry, stewards' stores, and engineers' mess rooms. Forward of the dining and sleeping saloons are lavatories, and the space forward of these is taken up by accommodation for the stewards and crew. Aft of the first class sleeping rooms is the sleeping accommodation for the officials connected with the customs, postal and railway departments.

From the lower deck, a stairway leading from the center of the first class accommodation gives access to the promenade deck, which is divided into smoking room, lounge, ladies' room, regal apartments, and dining saloon, with accommodation for the captain and first and second officers. The smoke room is at the aft end of the promenade deck and measures 21 feet 8 inches by 24 feet 6 inches. The furnishing is in fumed oak, Old English in style. The lounge, 24 feet 8 inches by 24 feet 6 inches is in grey sycamore, finished with a high polish in a free treatment of German Renaissance. Leading from the lounge is the ladies' anteroom, which is in dark mahogany with grey panels. From the lounge, access is had to the first class entrance hall, which leads up from the car deck, and leading forward from the grand entrance is the regal room, 10 feet 10 inches by 16 feet 6 inches, which is carried out in the Adams style. The dining saloon, 39 feet 4 inches by 32 feet, is treated in Italian Renaissance, and has seating accommodation for eighty persons.

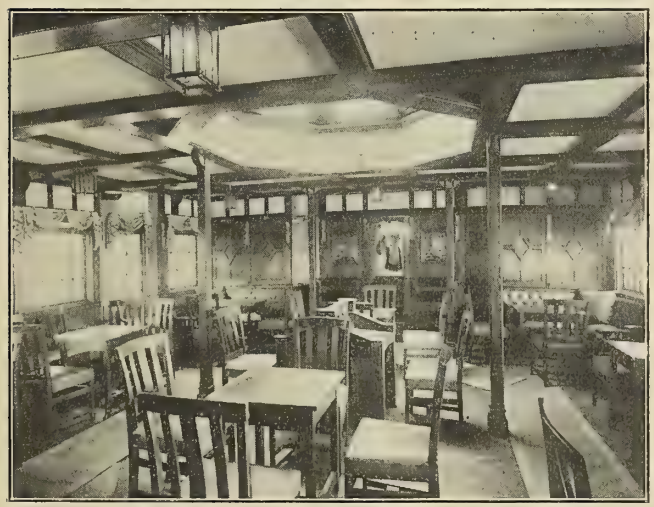
Two search lights are fitted, one at the fore end of the ship, and one the aft end, both of which are operated, and the direction of the beam of light controlled by electrical means from two control pillars, one on the forward bridge and one on the aft bridge. Fresh air, heated or cooled as may be necessary, is driven through galvanized iron trunks into the passenger accommodation by three thermo tanks, and the foul air is exhausted by a number of exhaust fans arranged in connection with exhaust ventilation trunks. There are three dynamos, each having an output of 600 amperes at 65 volts. The dynamos are each direct-coupled to a compound engine of 65 horsepower. The electrical power is controlled by a large switchboard, mounted on marble, and arranged so that the engineer has complete control of the lighting ar-



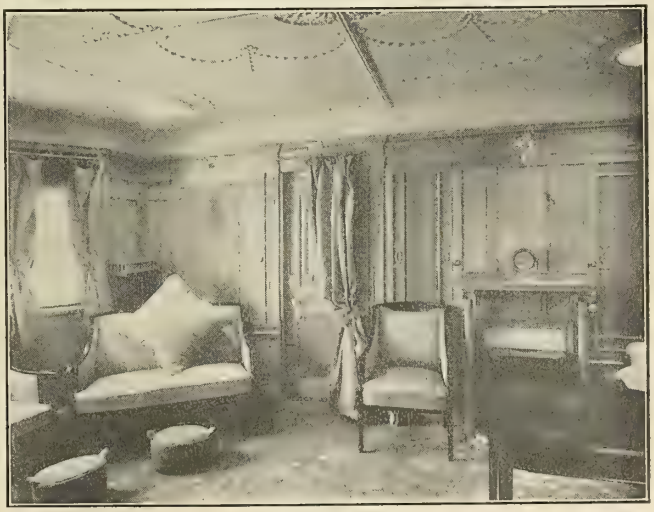
TYNE-BUILT FERRY STEAMER FOR THE BALTIC SERVICE.

rangements required at any hour of the day. In order that the engineer and captain may both know the speed of the main engines, a small electric generator is driven by chain gearing from each main engine shaft. Each generator (or transmitter) is connected by electric wires to two receivers, one in the engine room and one on the bridge, and these indicate, not only the speed of rotation, but also the direction in which the propeller is revolving.

The vessel is fitted with steering gear forward, as well as aft, to enable it to be navigated astern as well as ahead. When steaming ahead, only the aft gear is in use, but when steaming astern, both the forward and aft gears may be con-



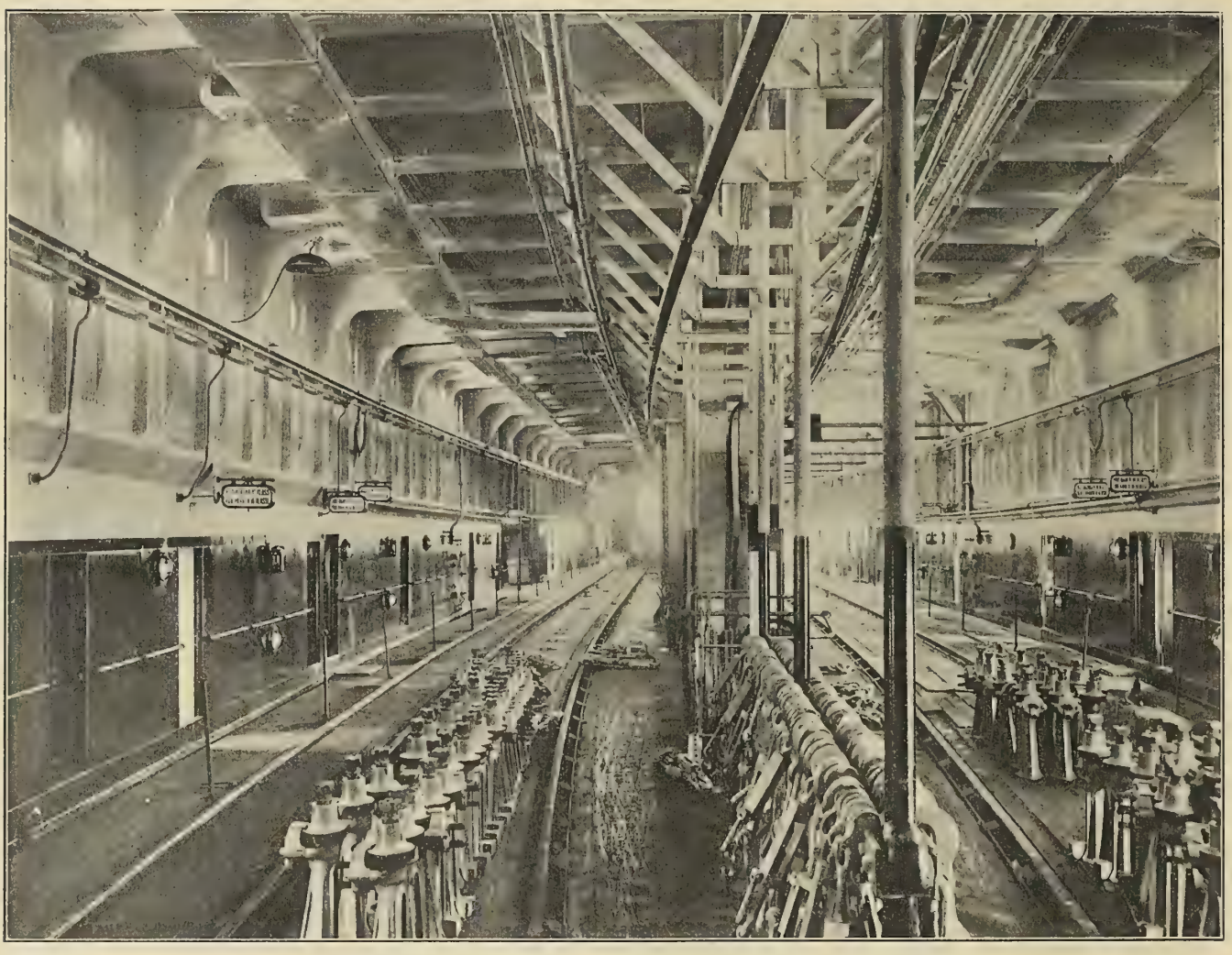
SMOKING ROOM.



THE REGAL APARTMENT.

trolled at will from the aft bridge. Each steering engine is fitted with an electric transmitter connected to indicators on the bridges, which show the angle of the rudder. Thus, on the forward bridge there is an indicator showing the angle of the aft rudder, but not of the forward rudder, while on the aft bridge there are two indicators.

There is also fitted on board the Stone-Lloyd's system of watertight doors, with electric indicating lamps in the chart room. Apparatus with two telephone receivers, also placed in chart room, is provided for the detection of submarine signals. The electric-bell system is so arranged that the train



VIEW SHOWING THE DECK UPON WHICH THE RAILWAY TRAINS ARE CARRIED.

wiring is connected to that of the ship by a connection at the buffers, so that passengers on the train may be enabled to call the ship's stewards to attend them. The train accumulators are also similarly replenished from the ship's mains while the train is on board, and there is steam connection at the buffers, by which means steam is transmitted to the railway vehicle while on the car deck. The standard compass is fitted on a long pole at the height of about 28 feet above the navigating deck, so that it is out of the range of the effect produced by the cars.

Since her introduction into regular service, the *Drottning Victoria* has proved herself possessed of excellent sea-going qualities, and quite capable of regularly maintaining the contract speed of 16½ knots. The vessel was built to the order of the Swedish Government by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Shipyard, Walker-on-Tyne.

Turbine Generating Sets in the Navy.

The U. S. S. *Connecticut,* flagship of the battleship fleet, has recently had installed in her forward dynamo room four 100-kilowatt turbine generators, to replace high-speed engine-driven sets. These are shown in the illustration, assembled at the Hartford works of the turbine builders—the Terry Steam Turbine Company.

The turbines are of the two-stage type, designed to operate with 200 pounds initial steam pressure and 25 inches vacuum, at a speed of 1,700 revolutions per minute. Steam enters through the throttle valve into the strainer; thence through the emergency valve, which is kept open against a spring by trigger, and then passes through the governor valve controlled by the main governor.

The emergency valve is tripped either by the emergency over-speed governor on the vertical worm shaft, or by the relief valve on the low-pressure stage. This valve is set to blow off at about 15 pounds pressure, and in blowing it operates the trip. A fly ball type of governor is used direct-connected to the turbine shaft operating balanced mitre throttle valve.

Steam passing through the controlling valve enters the first set of high-pressure steam jets, and thence to the wheel and the multiple velocity stages characteristic of this turbine. After doing its work in the high-pressure stage, the steam is again expanded through similarly arranged nozzles and reversing chambers in the low-pressure stage, and

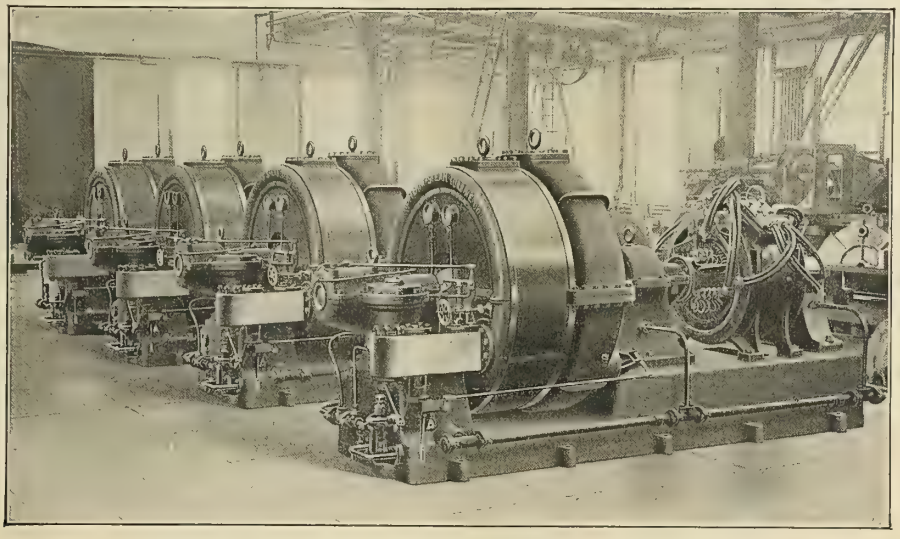
thence through the exhaust to the condenser. Full load can be obtained when exhausting non-condensing, by opening an additional valve in the high-pressure stage.

The turbine casings are bolted to and supported by the main bearing pedestals, no feet being fitted on the casing proper. In this way it is free to expand; the forward pedestal being provided with a sliding foot.

Positive oil circulation is maintained to all bearings by a centrifugal oil pump at the bottom of the vertical worm shaft. The oil is drawn from the reservoir in the base of the turbine under the forward pedestal, and the reservoir is provided with coil pipe for water cooling. The oil is drained back from the bearings through filters into the oil reservoir.

A flexible shaft coupling connects the turbines to generators, which are furnished by the Diehl Manufacturing Company. The generators are 100-kilowatt, 125-volt, direct-current, compound-wound machines, fitted with inter commutating pole pieces. The double commutators are of special design, adapted for high velocities, and are mounted on a spider, which, in turn, is substantially keyed to the armature shaft. The brush area is proportioned for low-current density. These sets are built to conform to the Bureau of Equipment Specifications.

The increasing extent to which electricity is being used for lighting and power on board our battleships is shown by comparison of the *Connecticut's* dynamo equipment with that of the *Florida* or *Arkansas* now building. The *Connecticut* has eight 100-kilowatt units, while the new ships are each to be fitted with four 300-kilowatt sets of this same type.



TURBINE GENERATING SETS FOR THE BATTLESHIP CONNECTICUT.

Clyde Turbine Steamer Atalanta.

BY ALLAN M'PHERSON.

The turbine steamer *Atalanta,* built by Messrs. John Brown & Co., of Clydebank, and owned by the Glasgow & South Western Railway Company, is typical of the splendidly equipped day excursion steamers on the Firth of Clyde.

Her principal dimensions are as follows:

Length between perpendiculars	227 feet 0 inches
Breadth molded	27 feet 0 inches
Depth	10 feet 6 inches
Draft	5 feet 6 inches
Displacement	520 tons
Block coefficient	0.54
Indicated horsepower	2,500
Speed	18 knots
Tonnage, gross	400 tons

She is built of mild steel to Board of Trade requirements.

The machinery of the vessel is of historic interest, because she is fitted with the complete turbine set, which Messrs. Brown specially constructed for the extensive series of experiments, to determine many unsolved problems associated with the design of the turbines for the *Lusitania.* On the *Atalanta* the three-shaft system has been adopted, with one high-pressure turbine on the center shaft and one low-pressure turbine on each side shaft. The astern turbines are also on the side shafts inside the low-pressure cylinders.

There are two condensers placed in the wings of the ship, and each is connected to one of the two low-pressure turbines by eduction pipes of extra large size, an important necessary provision in view of the advantages of high vacuum with turbines. Water is circulated through the condensers by two centrifugal pumps.

Steam is supplied by two cylindrical boilers of the navy type, which are designed for a working pressure of 150 pounds per square inch.

On each propeller shaft there is one three-bladed propeller of bronze.

On trial trip the *Atalanta* maintained a mean speed of 18.1 knots on the double run between the Cloch and Cumbrae light houses.

The ship has four decks—lower, main, promenade and shade. The promenade deck extends from stem to near the stern and the full width of the ship. On the promenade deck forward is the chart house and entrance to the second class saloon, with the flying bridge above it. On the same deck aft, are the purser's office and main entrance to the first class saloon, with the shade deck overhead. There are two lifeboats on davits at the stern. The deck seats are of the garden pattern, with buoyancy tanks for life-saving. The main deck extends the full length of the ship and is plated all fore and aft, with the exception of a short portion of the stern in way of capstan and steering gear. On the main deck forward is the second class saloon, which forms a shelter in wet weather, and on the main deck aft is the first class saloon, which is framed in light oak. The windows are square and very large, giving a clear outlook. Adjacent to this saloon there is a tea room and a smoke room. The first class dining-saloon is on lower deck aft, and the second class on

lower deck forward. The ship is provided with steam-steering gear controlled from the flying bridge. There is a steam windlass and capstan forward, and a steam capstan aft. The vessel is fitted with electric lamps throughout.

THE INFLUENCE OF THE DEPTH OF WATER ON THE RESISTANCE AND SPEED OF HIGH-SPEED TORPEDO CRAFT.

The total resistance of a ship may be divided up into

1. Skin friction resistance.
2. Eddy-making resistance.
3. Wave-making resistance.

(2) and (3) are sometimes taken together and called the residuary resistance, as both follow Froude's law of comparison in deducing the resistance of a ship from its model. At high speeds the wave-making resistance is relatively the most important, and forms the greatest part of the total resistance. It is the alteration of the wave-making resistance, which is the most remarkable phenomenon when a ship travels into shallow water.

The nature of the wave formation depends on the variations of pressure at the bow and stern of a vessel in motion through water. These variations of pressure are affected by the boundaries of the water in which the vessel moves. Proximity of the bottom would, therefore, tend to alter the deep-water wave formation, and, consequently, the deep-water wave-making resistance. On the other hand, the effect of the bottom would be to produce an additional frictional "drag" on the ship and so tend to increase the skin friction. Alteration of a vessel's deep-water resistance is, therefore, to be anticipated when she enters shallow water.

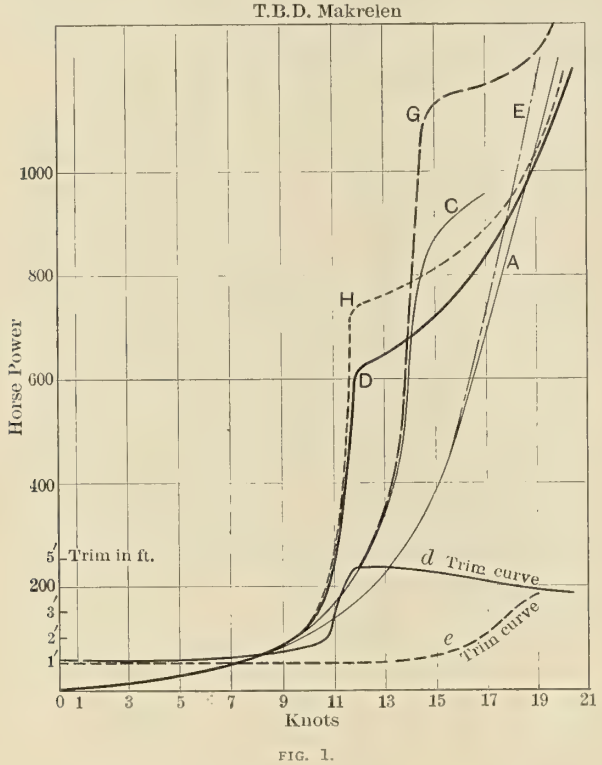


FIG. 1.

Scott Russell, as long ago as 1835, observed this alteration of resistance in the case of a barge being towed through a canal. He found that as the speed increased so did the resistance up to a certain point. After that point was reached the resistance dropped. He made careful measurements of the tow-rope pull at different speeds, and found the speed at which the resistance began to drop corresponded with that of the wave of translation for the depth of water in the canal. The curve of resistance on speed was of the nature indicated in the figure, and the speed at which the resistance began to decrease was approximately given by $V = \sqrt{g\ h}$, where g = acceleration due to gravity.

h = depth of water in canal in feet.

V = speed of wave of translation in feet per second.

Scott Russell noticed particularly that up to the speed of translation oscillating wave motions were set up and also a great disturbance in the wake left by the barge. At approximately the speed of translation the disturbance disappeared, and the vessel appeared to be traveling on a single wave.

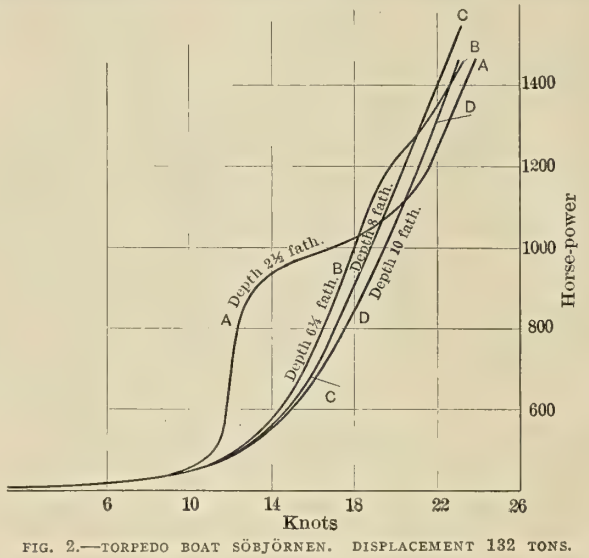


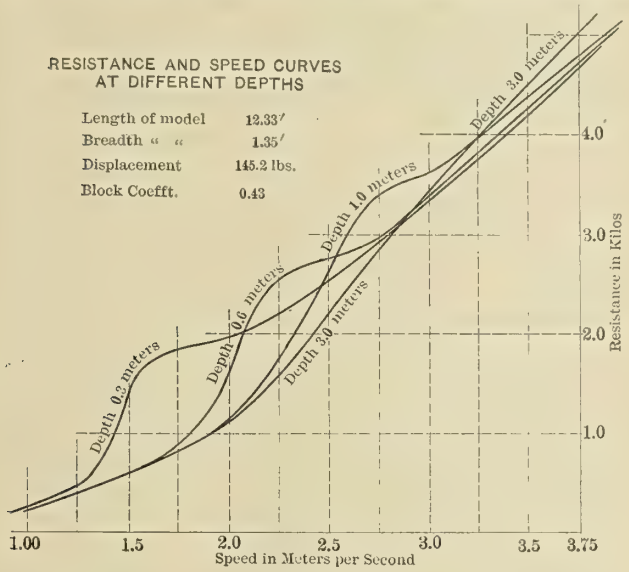
FIG. 2.—TORPEDO BOAT SÖBJÖRNEN. DISPLACEMENT 132 TONS.

Sir William White, in his *Manual of Naval Architecture,* gives details of the performance of actual ships in shallow water. For instance, he mentions that H. M. S. *Edgar,* in the Stokes Bay measured mile, required 13,260 indicated horsepower to get 20½ knots in 12 fathoms. In water 30 fathoms deep she attained a speed of 21 knots with 12,550 indicated horsepower.

Messrs. Yarrow experienced some difficulty in getting the contract speed of 25½ knots on the Maplins mile at the mouth of the Thames for the river-class destroyers built by them for the British Admiralty. This was rightly ascribed to the effect of the depth of water in which the trials took place. The firm carried out a series of progressive trials, and model experiments were made to find out what the effect of shallow water was on their boats. These results were laid before the Institution of Naval Architects in 1905. Other experiments have been made by Herr Popper and Messrs. Denny.

Capt. Rasmusser, of the Danish navy, carried out some extremely interesting research work on the resistance of torpedo craft in shallow water (see Trans I. N. A., 1899). Figs. 1 and 2 are curves of horsepower on speed for two torpedo boats. In addition, Fig. 1 shows the effect of alteration of displacement and the variation in trim of the torpedo boat *Makrelen,* when running in different depths of water at varying speeds. In Fig. 1 it will be noted in the shallow depths (given by curves *D* and *H, C* and *G*) the speeds of waves of translation are reached. Thus the speed of a wave of translation in a depth of 2 fathoms is nearly 11 knots, and that in a depth of 3¼ fathoms is about 14 knots. These speeds approximately coincide with the critical speeds at which the points of inflexion occur (and it is seen that the latter correspond to the same speed for both displacements). In other

words, the critical speed is independent of displacement. However, this cannot be taken as established on the information available, since only the horsepower curves at two displacements of the same vessel are given. The trim curves *d* and *e*, corresponding respectively to the shallow depth of curve *D* and the full depth of curve *E*, show that in shallow water at the critical speed we get an abnormal trim by the stern, but after passing that speed the trim decreases and approaches that in deep water. Comparing curves *A* and *D* of Fig. 1, it will be observed that at a speed of about 18¾ knots the curves cross. At speeds below 18¾ knots the horsepower for the same speed is greater in shallow than in deep water; above that speed the reverse holds, and in shallow water at speeds above 18¾ knots we get a greater speed than would be obtained in deep water for the same expenditure of horsepower. Fig. 2 establishes the same thing for another torpedo boat run at high speeds in depths of water varying from 2½ to 10 fathoms. These curves, Figs. 1 and 2, show also that



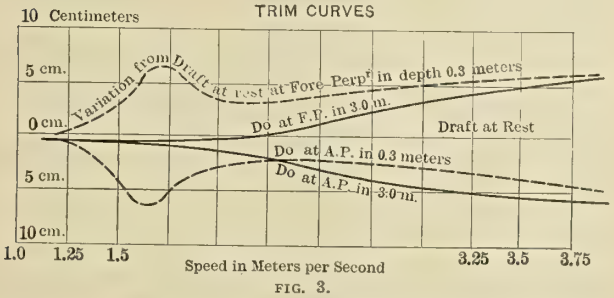


FIG. 3.

the points of inflexion in the horsepower curves become more marked and occur at lower speeds as the water shallows.

Major Rota (now lieutenant-colonel), of the Royal Italian navy, made experiments on models in the Italian tank at Spezia, one of these models representing a torpedo boat. The results of these experiments are of the greatest importance, and the experiments themselves may properly be termed classical. Figs. 3 and 4 exhibit the results obtained with the torpedo boat model run at a constant displacement. This model was 12.33 feet long, 1.35 feet broad, with a displacement of 145.2 pounds. The block coefficient was 0.43. Rota's curves of resistance on speed for different depths of water (Fig. 3) show just the same characteristics as the curves of Rasmussen and other experimenters. The most important of these characteristics may be summarized as follows:

1. The points of inflexion in the horsepower on resistance curves become more marked and occur earlier the shallower the water.

2. At high speeds for the same expenditure of horsepower it is possible to get a greater speed in shallow than in deep water.

3. All the curves show that the point of inflexion occurs approximately at a speed given by $V^2 = g\,h$ (V being expressed in feet per second and h in feet). If V is expressed in knots and h in fathoms, the formula for the critical speed becomes $V^2 = 60\,h$, h being the depth of water in fathoms.

Both Rota's and Rasmussen's results show the marked alteration in trim at and near the critical speed. Observation has shown that as a vessel traveling at a high speed enters shallowing water the trim by the stern begins to increase, and continues to increase until the speed of the wave of translation is reached corresponding to the depth of water. At this speed the vessel seems to be traveling on the back slope of a steep, solitary wave, and the ordinary oscillating transverse wave system seems to have disappeared.

Rota assigned the alteration in resistance in shallow water to the abnormal trim by the stern, but the phenomenon would appear to admit of a fuller explanation. The principal feature in wave-making resistance is that at a certain speed in relation to the length of the vessel there is a great and usually sudden increase of resistance. This is clearly shown by the humps in the curves of resistance or horsepower on speed. The center

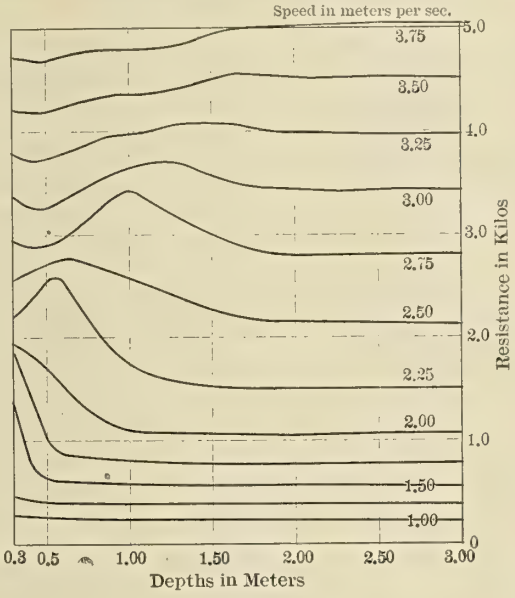


FIG. 4.

of the hump approximately coincides with the speed at which the length of the wave* corresponding to that speed agrees with the distance between the bow and stern primary waves which the hull tends to form. The hump in the curve will hence occur when a certain conjunction of bow and stern-wave lengths is effected.

Now, the wave length* corresponding to the speed of the vessel is affected by the depth of water when that depth is below a certain limit, so that as the depth of water decreases so does the speed of the wave, and the hump is pushed further and further down the curve until we reach a state of things when the ordinary wave system cannot be formed. The stern transverse system has disappeared and the bow system has become degraded into a single wave of translation. This wave

* (In oscillating waves, if V be speed of wave, and L be length of the same, then, in deep water $V^2 = \frac{gL}{2\pi}$, and in shallow water $V^2 = K\frac{gL}{2\pi}$ where K is less than unity and depends on depth of water when that depth is below a certain limit. Hence it is seen that a shallow-water wave must travel at a less velocity than a deep-water wave of the same length.)

when once formed absorbs no further energy from the vessel. The only large resistances are then those due to skin friction and eddies.

It is thus seen that after the wave of translation is once set up the total resistance decreases, and it is then clear why a vessel at high speeds in shallow water below a certain depth is able to obtain a greater speed than in deep water for the same expenditure of horsepower.

It is very interesting to apply Rota's curves (Fig. 4) to actual vessels using Froude's law of comparison. This law is only applicable to the residuary resistance, and, strictly speaking, in applying model results to actual vessels regard should be had to the skin friction correction. The law of

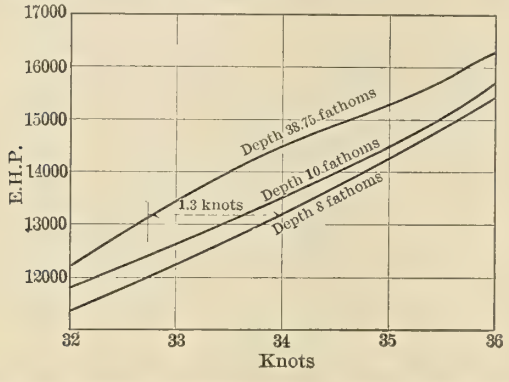


FIG. 5.—E. H. P. CURVES FOR 860-TON SHIP. (BASED ON ROTA'S CURVES.)

comparison applied to the total resistance of a model will give a rather larger estimate for the total resistance of the ship. However, at high speeds, and before the oscillating wave system becomes merged into a wave of translation, a first approximation to the results to be expected for actual ships which are substantially similar in form to Rota's model may be obtained by using Froude's law. This states:

"If the linear dimensions of a ship be one time that of its model and the resistances of the latter are r_1, r_2, r_3—at speeds V_1, V_2, V_3—the resistances of the ship will be $r_1\ l^3$, $r_2\ l^3$, $r_3\ l^3$; at corresponding speeds $V_1 \sqrt{\ l}$, $V_2 \sqrt{\ l}$, $V_3 \sqrt{\ l}$." * * *

Applying this law to an 860-ton destroyer the dimension

$$l = \sqrt[3]{\frac{\text{displacement of ship}}{\text{displacement of model}}} = 23.7.$$

Now, depth will vary as l.

Speed as $\sqrt{\ l}$.

Resistances as l^3.

Horsepowers as $l^{7/2}$.

Hence 8 fathoms for the destroyer corresponds to about 0.6 meters in the model; 10 fathoms for the destroyer corresponds to about 0.77 meters in the model; 38¾ fathoms for the destroyer corresponds to about 3.0 meters in the model. Hence, interpolating in the curves in Fig. 4 we can get the resistance on speed curves of the model at depths 0.6, 0.77 and 3 meters. The resistances and E. H. P's of the ship are then readily deduced by Froude's law. The table gives the estimate of the E. H. P's for an 860-ton destroyer at different depths of water:

	E. H. P. in		
Speed.	8 Fathoms.	10 Fathoms.	38¾ Fathoms.
32 knots.....	11,300	11,750	12,300
33 "	12,400	12,600	13,450
34 "	13,300	13,600	14,500
35 "	14,300	14,450	15,300
36 "	15,250	15,750	16,450

These results are plotted in Fig. 5, and show that the increase of speed for such a vessel obtained by running in shallow water of 8 fathoms is about 1.3 knots over what would be obtained in deep water of 38¾ fathoms when developing the same E. H. P.

This result is confirmed in a striking manner by data given in a paper read by Sir Phillip Watts before the I. N. A. at the recent spring meetings on the speed trials of the torpedo boat destroyer *Cossack* at the Maplins and Skelmorlie. (See International Marine Engineering, July, 1909, page 256.) The naval list displacement of the *Cossack* is given as 885 tons, and the depth of water in which she ran was 7.4 fathoms on the Maplins and 40 fathoms at Skelmorlie. For the same shaft-horsepower to produce 34 knots on the Maplins she got about 1.4 knots less at Skelmorlie. The actual results are seen to be

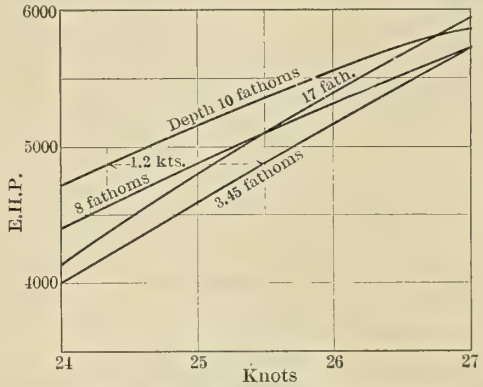


FIG. 6.—E. H. P. CURVES FOR 600-TON SHIP AT DIFFERENT DEPTHS.

in very close agreement with the results obtained from Rota's curves.

As already pointed out, the E. H. P's given in the table are overestimated, but for small ranges of speed in the neighborhood of the high speeds taken, the skin friction correction would reduce these E. H. P's approximately pro rata, and, therefore, would not affect the value of the estimate for gain or loss of speed due to shallow water. Rota's curves are hence of the greatest practical value.

For a 600-ton destroyer (say of the river-class type), calculations based on Rota's curves neglecting the skin friction correction give:

	E. H. P. in			
Speed.	8 Fathoms.	10 Fathoms.	17 Fathoms.	345 Fathoms.
24 knots....	4,425	4,775	4,180	4,000
25 "	4,875	5,150	4,800	4,560
26 "	5,320	5,350	5,400	5,170
27 "	5,750	5,900	5,950	5,740

Fig. 6 shows these results plotted. Of the four depths taken it is seen that the greatest depth is the most favorable. A 600-ton destroyer, which develops 25½ knots in 34½ fathoms, would decrease her speed by about 1.2 knots in 10 fathoms, .5 knot in 8 fathoms, and .4 knot in 17 fathoms, assuming the E. H. P's were the same in each case. Fig. 7 shows the E. H. P. curves of a 750-ton destroyer at different depths of water, based on Rota's curves. Of the four depths taken, viz.: 8, 14, 17 and 37 fathoms, it will be seen that the extreme depths of 8 and 37 fathoms are the most favorable for a speed of, say, 28 knots, there being little to choose between them. Such a destroyer which obtains 28 knots in 37 or 38 fathoms would get about 1¼ knots less in water 14 fathoms deep, and about ¾ knot less in 17 fathoms. For 29 knots the shallowest depth is the most favorable.

The determination of the minimum depth of water to obtain the normal deep-water resistance is of the utmost importance in arriving at the true speed of the ship. In arriving at an estimate we can again have recourse to Rota's curves in Fig. 5.

In the case of the 860-ton ship 3.75 meters per second in the model correspond to about 35.5 knots in the ship; 3.5 meters

per second in the model correspond to about 33.2 knots in the ship; 3.25 meters per second in the model correspond to about 30.4 knots in the ship; 3.00 meters per second in the model correspond to about 28.6 knots in the ship; 2.75 meters per second in the model correspond to about 26.3 knots in the ship. Also a depth of 2.0 meters for the model corresponds to 26 fathoms for the ship; 2.5 meters for the model corresponds to

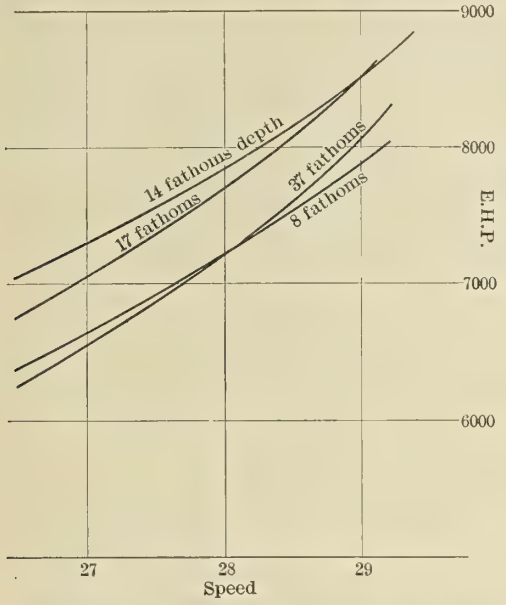


FIG. 7.—E. H. P. AND SPEED CURVES FOR 750-TON SHIP. (BASED ON ROTA'S CURVES.)

32.6 fathoms for the ship; 3.0 meters for the model corresponds to 38.75 fathoms for the ship.

Now, for speeds of from 3.0 to 3.75 meters per second an inspection of Rota's curve in Fig. 4 shows that the resistance curves are parallel to the base line. Hence for the 860-ton ship it would appear that at speeds of from 30 to 35 knots a minimum depth of about 33 fathoms is sufficient to obtain the normal deep-water resistance. For the 600-ton ship, at speeds of from 22 to 27 knots, a minimum depth of 23 fathoms would be sufficient. Similarly, for the 750-ton ship, at speeds of from 27 to 30 knots, the minimum safe depth for the normal deep-water resistance is about 27 fathoms. J. R.

TWIN-SCREW STEAMER FOR SUBMARINE MINE SERVICE.

BY HARRY L. FULLER AND V. R. MARSDEN.

The steamer *Gen. E. O. C. Ord* was launched Feb. 13, 1909, at the yards of the Pusey & Jones Company, of Wilmington, Del. The boat was designed by the Quartermaster's Department, U. S. A., Washington, D. C., and is of the following dimensions:

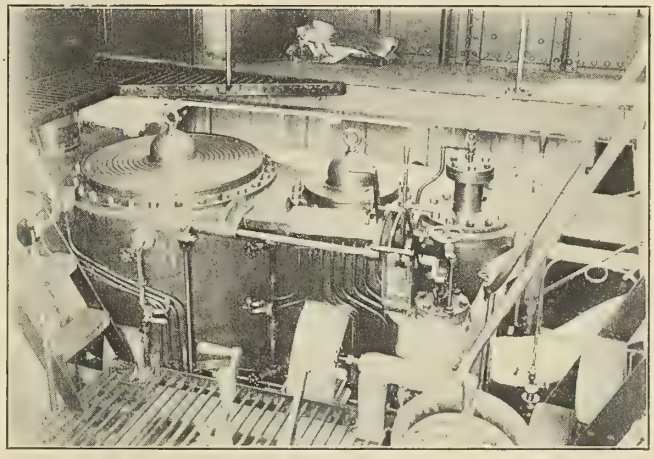
	Feet.
Length on deck	165
Length on loadline (10 feet above base)	154
Breadth of beam, molded	32
Depth, molded, amidships	17
Draft, loaded	10
Speed per hour (statute miles)	13

The hull is constructed of the best open-hearth mild steel, having a tensile strength of not less than 38,000 pounds, nor more than 68,000 pounds per square inch of section, and under the inspection and gage tests of the American Bureau of Shipping.

The steamer is divided into five compartments by watertight cross-bulkheads. A double bottom extends nearly the entire length, and is divided into compartments, which provide for the safety of the ship in event of grounding, and which can also be used to vary the trim and draft by means of water ballast. There is also one tank in the forward peak and one in the after peak, used for fresh water and trimming of the ship.

The double bottom is of the cellular type, and extends from frame No. 6 to frame No. 78. The center-line vertical keel is continuous, of 16-pound plate, 42 inches deep from frame No. 6 to frame No. 35, 36 inches deep from frame No. 55 to 34 inches deep at frame No. 78, 30 inches deep from frame No. 37 to frame No. 53. The keel is double-butt strapped with 12-pound plate, treble riveted, and secured to the flat keel plate and tank top by double-continuous angles; the bottom angles being 4 inches by 3 inches by 8.5 pounds and the top

THE GEN. E. O. C. ORD.



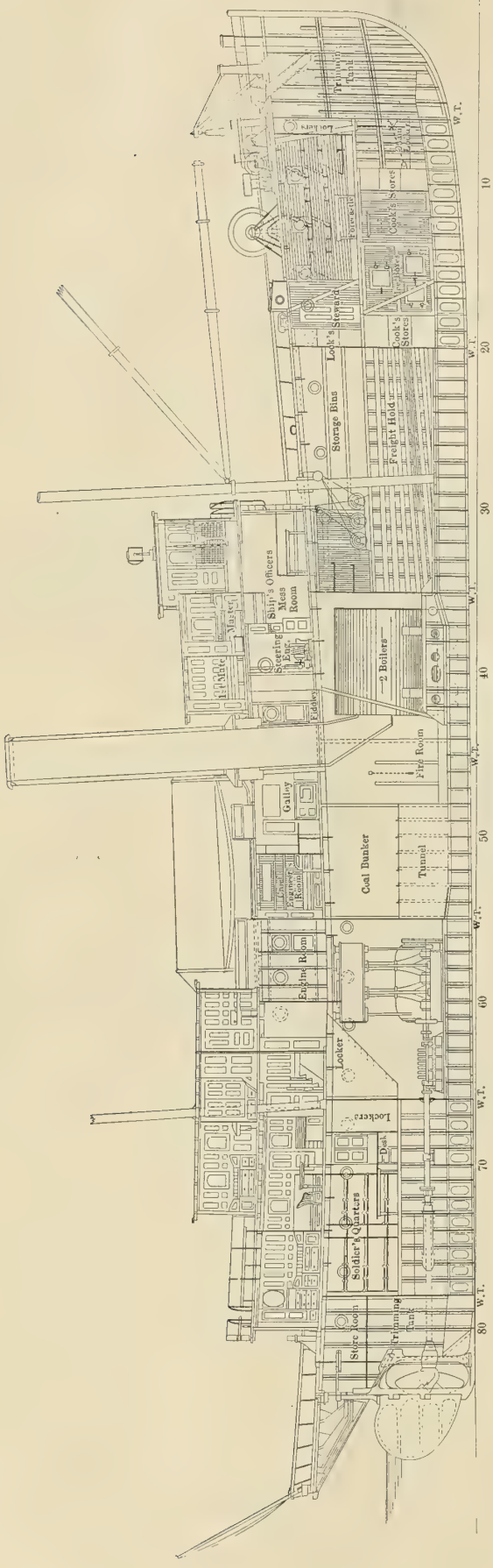
VIEW OF PORT ENGINE.

angles 3½ inches by 3 inches by 7.8 pounds. The angles connecting the vertical plate with the transverse floors are 3 inches by 2½ inches by 6.6 pounds, double.

The flat keel plates are 36 inches wide by 22 pounds, and worked in lengths of not less than nine frame spaces. The butts are treble riveted, 28 pounds, and extend to the edge of the garboard strakes.

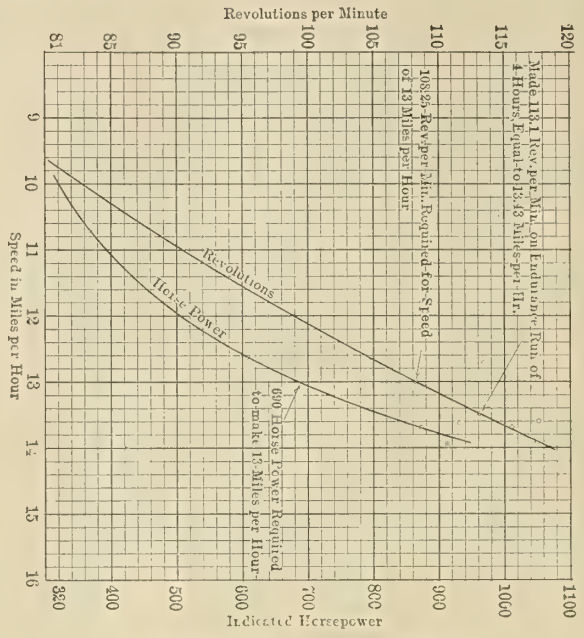
There are two longitudinal keelsons on each side of the center line, worked intercostal between alternate floors, and properly lightened with manhole openings. They are of 14-pound plate, and extend as far into the ends as practicable; all secured to the shell plating, tank tops and floors by 3 inches by 2½ inches by 6.6-pound angles. Under the engines the floors, or longitudinals, are continuous.

The tank side margin plates are of 14-pound steel, worked



LONGITUDINAL SECTION

INBOARD PROFILE OF GEN. E. O. C. ORD, SHOWING LOCATION OF HOLDS, MACHINERY AND LIVING QUARTERS.

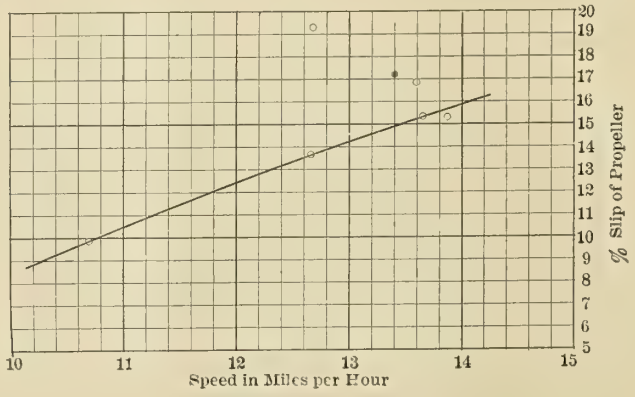

Revolutions per Minute
Speed in Miles per Hour
Indicated Horsepower
Revolutions
Horse Power
600 Horse Power Required to make 16 Miles per Hour
10825 Rev. per Min. Required for Speed of 13 Miles per Hour
Made 113.1 Rev. per Min. on Endurance Run of 4 Hours, Equal to 12.43 Miles per Hr.

REVOLUTION AND HORSEPOWER CURVES.

continuous and flanged for connection with the tank-top plating, 3 inches by 3 inches by 7.2-pound angles, worked continuous at the lower edge. There are transverse floors on every frame, and alternate floor plates worked intercostal between longitudinals, with 3 inches by 2½ inches by 6.6-pound angles, and secured to the shell plating by 3 inches by 3 inches by 7.2-pound angles; other floors are continuous from the tank margin to the vertical keel, the continuous floors being lightened by manhole openings between longitudinals except at watertight divisions, where all construction is properly stapled, riveted and calked thoroughly watertight. All floors are of 14-pound plate with angles as above, except under the boiler saddles and engine foundation, where they are of 16-pound plate. The floors at the ends are reduced to 12-pound plate. Deep floors are provided in trimming tanks, as shown on the longitudinal section, also at the forward end of the stern tubes, all properly stiffened.

The tank-top plating is of 14-pound steel reduced to 12 pounds at the ends. The middle strakes throughout the engine and boiler spaces are of 16-pound plate, laps single riveted and butts double riveted.

The shell plating is in seven strakes, amidships on each side. Of the latter, the garboard strake *A* measures 18 pounds throughout. Strakes *B* and *D* measure 16 pounds and 17.5 pounds forward and 14 pounds aft. Strake *C* measures 16 pounds aft and amidships and 17.5 pounds forward. Strake *E* measures 16 pounds amidships and 14 pounds at the ends.

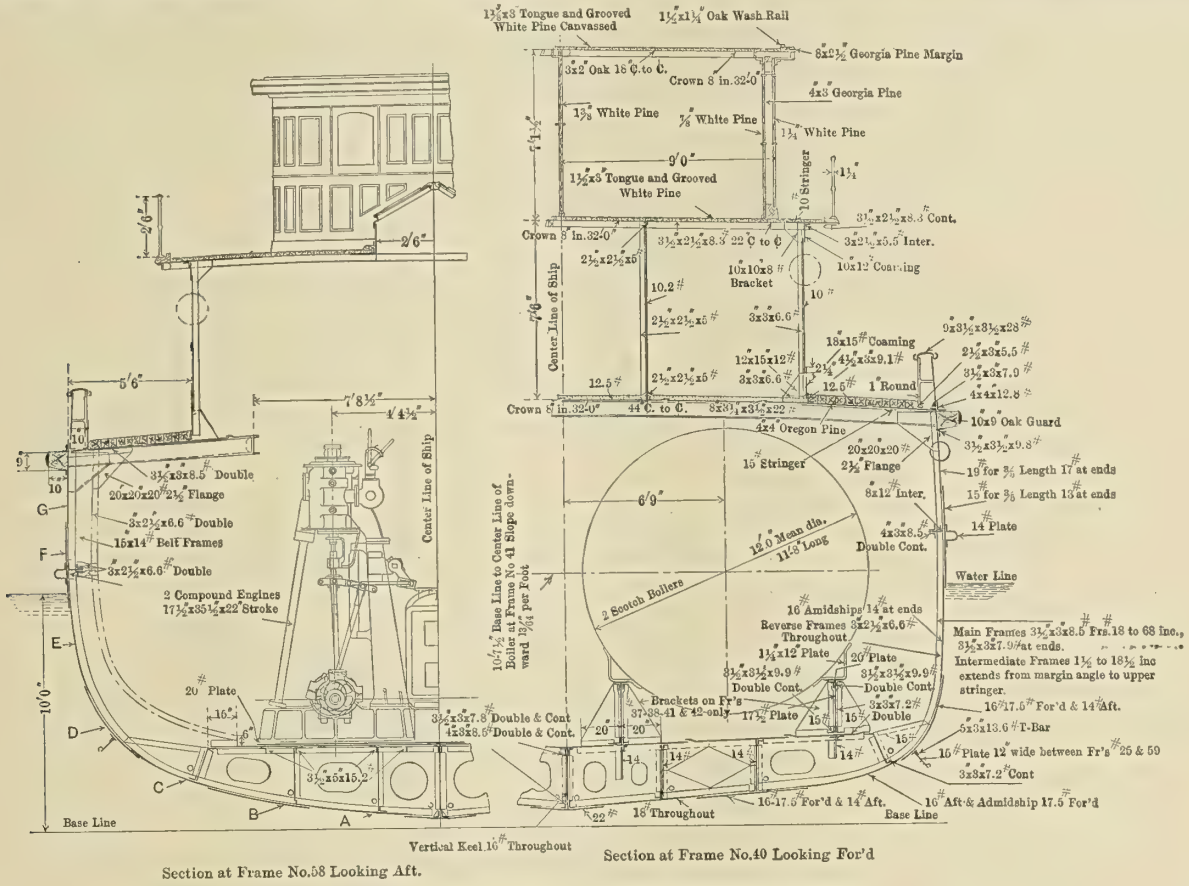


PROPELLER SLIP CURVES.

Strake *F* measures 15 pounds for three-fifths length and 13 pounds at the ends. There are two bilge keels, extending on each side of the ship from frame No. 25 to No. 59, composed of 5 inches by 3 inches by 13.6-pound tee bars riveted to the shell and riveted to 15-pound plate, 12 inches wide, with a 2½-inch hollow half-round bar riveted to the outside edge on the upper side. All strake laps are 4½ inches wide, and are joined by ¾-inch double riveting.

The main frames are 3½ inches by 3 inches by 8.5 pounds; 3½ inches by 3½ inches by 7.9 pounds at the ends extending in one piece from the margin angle, or keel, to the main deck, spaced 22 inches centers. Intermediate frames, 3½ inches by 2½ inches by 6.6 pounds in the eighteen forward frame spaces, extend in one piece from the margin angle, or keel, to the upper stringer. Reverse frames, 3 inches by 2½ inches by 6.6 pounds are located on every frame extending in one piece from the margin angle, or keel, to the upper stringer and main deck, alternately, except in the engine and coal bunker spaces, where all extend to the main deck. Belt frames, 15 inches wide, of 14-pound plate, double-face angles, 3½ inches by 2½ inches by 6.6 pounds, are on frames 25, 30, 38, 42, 48, 51, 59 and 63. The stem is a bar-iron forging, 1¾ inches by 8 inches, and the stern frame, 3½ inches by 8½ inches, of cast steel.

The main deck beams are channels, 8 inches by 3½ inches by 3½ inches by 22 pounds and 7 inches by 3½ inches by 20 pounds at the ends, spaced 44 inches centers. The berth deck beams are 5 inches by 3 inches by 11.3 pounds and 4 inches by 3 inches by 9.8 pounds at the ends, spaced 22 inches centers. The deck-house beams are 3½ inches by 2½ inches by 8.3 pounds, spaced 22 inches centers. The main deck and deck-house beams have a crown of 8 inches in 32 feet. Bulkhead angles are 3½ inches by 3½ inches by 8.5 pounds.



MIDSHIP SECTION OF GEN. E. O. C. ORD, SHOWING SCANTLINGS.

The main engines are in a single engine room without a center-line bulkhead, the starting platform being very conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are fitted with safety valves in the bottom and cover. The cylinders are supported by hollow cast iron columns on the inboard side, and high-grade machinery steel columns, 3½ inches diameter, bolted to the bed-plate on the outboard side. All stuffing-box packings of the main engines are Katzenstein's metallic packing.

The steam pipe to each engine is 5 inches diameter. The pipe carrying steam from the high-pressure to the low-pressure cylinder is 8 inches diameter, and the exhaust from each engine to the condenser is 10 inches diameter. The main engines also have a 7-inch exhaust from each engine, combining into a 10-inch pipe, leading through the side of the ship to the atmosphere, just below the main deck, with a stop valve on the skin of the ship. All steam and exhaust pipes to and from the main engine are of copper.

The shafting, which is made of the best forged steel, con-

MACHINERY.

There are two main engines of the two-cylinder, vertical, direct-acting compound type, well balanced, and each capable of developing about 345 indicated horsepower at 108.25 revolutions per minute, at a steam pressure of 150 pounds per square inch. The illustration shows the port engine as installed in the ship. The sequence of cylinders, beginning forward, is high-pressure and low-pressure, with diameters, respectively, 17½ inches and 35½ inches and a common stroke of 22 inches.

The cranks are set at 90 degrees. The high-pressure cylinder has one piston valve, with a diameter of 9 inches on top and bottom. The low-pressure cylinder has a flat, double-ported slide valve. The valve stems are in all cases 2¼ inches in diameter, while the piston rods are each 3½ inches diameter. The valves are operated by Stephenson's link motion from eccentrics, and are worked by a steam reversing

sists of crankshafts of the built-up type, with a diameter of 7½ inches; thrust shafts, 7½ inches diameter (7¾ inches between collars), and tail shafts, 7½ inches diameter.

The two propellers, which are four-bladed, one right and one left handed, are of the solid type, 8 feet diameter by 12 feet 3 inches pitch, and have a developed area of 30.9 square feet. It may be mentioned that the propellers are provided with guards to prevent cables from fouling them.

THE BOILERS.

Two single-ended Scotch boilers of the cylindrical type, working at a pressure of 150 pounds per square inch, are located in one boiler room, and have a single funnel. The furnaces, three in each boiler, have internal and maximum diameters of 39 inches and 42 27/32 inches, and are 27/64 inch thick. The grates are 6 feet ½ inch long, the grate surface of each boiler being 58.5 square feet, while the heating surface in each boiler is 1,874.5 square feet, or a ratio of 32 to 1; making for the two boilers an aggregate grate surface of 117 square feet, and a total heating surface of 3,749 square feet. The three furnaces have a common combustion chamber, and they are of the removable type. The length of tubes between tube sheets is 8 feet 4 inches, and they are spaced 4 inches apart in each direction. Each boiler contains 232 tubes, of which thirty-two are stay tubes; all have an outside diameter of 3 inches with a thickness of No. 6 B. W. G. for the stay tubes and No. 11 B. W. G. for the ordinary tubes. The tube sheets have a thickness of ⅝ inch. The top of the combustion chamber, which is ½ inch thick, is supported by the usual bridge girders. The funnel, which has a circular section, consists of an inner stack, 57 inches diameter, and an outer stack, 67½ inches diameter with an air space of 5¼ inches.

THE AUXILIARY MACHINERY.

The two main engines have a common condenser, with a cooling surface of 1,602.73 square feet. The cooling pipes are of seamless-drawn brass, with an outside diameter of ⅝ inch. The air pump is a 10 by 18 by 18 by 14-inch independent vertical beam pump. The circulating pump is also independent, and driven by a direct-connected vertical engine, 6 by 6 engines, working on a steam pressure of 100 pounds. A table is given of the exact number and style of pumps, with the location of their suction and discharge and the sizes of their various connections.

There is a 20-kilowatt, direct-connected General Electric Company turbine generator, which furnishes current for lighting the ship and also for the winches and capstans, which include one three-drum, 15-horsepower electric winch and one double-drum, 10-horsepower electric winch of the Lidgerwood make, located near the foremast on the intermediate deck in the hold, and in connection with the derrick gear above and two vertical capstans of the Hyde windlass make; one mounted on the center line just forward of forecastle companionway, with its shaft extending through a watertight connection in the deck, with gearing connecting to a 5-horsepower motor, and one mounted on the starboard side aft in connection with towing bitts in rear of deck house. This is of the vertical turning capstan type for rapid handling of tow lines, and is driven by a 5-horsepower motor installed under the deck, and connected by work gearing. All electric connections are made complete from a switchboard in the engine room, the after capstan being connected on an inde-

PUMP SCHEDULE.

NAME.	Type and Size.	Steam	Exhaust	Suction.	Discharge.
Main air.....	10–18–18 x 14" vertical beam.	1¼"	2"	7" condenser.....	6" overboard. 4" filter tank.
Circulating...	6 x 6" engine...	1½"	1¼"	8" sea..... 8" bilge.....	1¼" water service. 9" condenser.
Main feed...	9–5½ x 12" vertical L. S..	1"	1¼"	3" condenser (air pump channelway)..... 3" filter tank..... 3" F. W. tanks....	2½" boilers direct. 2½" boilers via feed. water heater. 2½" F. W. tanks. 2½" filter tank.
Auxiliary feed	9–5½ x 12" vertical L. S..	1"	1¼"	3" condenser (air pump channelway)..... 3" filter tank..... 3" F. W. tanks....	2½" boilers direct. 2½" boilers via feed water heater. 2½" F. W. tanks. 2½" filter tank.
Donkey.....	9–5½ x 12" vertical L. S..	1"	1¼"	3" sea..... 3" bilge manifold.. 2" boilers..... 2½" F. W. tanks...	2½" boilers direct. 1½" sanitary system. 2½" F. W. tanks.
Bilge.....	9–5½ x 12" vertical L. S..	1"	1¼"	3" sea..... 3" bilge manifold..	2½" firemain. 2½" condenser. 2" water service.
Fresh water..	4½–4'x 6" vertical L. S..	½"	¾"	2" F. W. tanks....	1½" F. W. system.
Sanitary.....	4½–4 x 6" vertical L. S.	½"	¾"	2" sea.....	1½" sanitary system.
2" injectors..	Metropolitan No. 12½ model "O"..	1½" each		1½" sea (each)..... 1½" F. W. tanks each.....	1½" auxiliary feedline (each). 1¼" hose connection (each).

STANDARDIZATION TRIALS

Left dock at 10.40; trial began 11.45; draft forward 10ft. 4 ins.; draft aft 10 ft. 2½ ins. mean draft for trip 10 ft. 3½ ins.; tons of coal on board, 50; number of men on board, 35. Returned to dock at 7.10; trial ended 6.24; draft forward 10 ft. 3 ins.; draft aft 10 ft. 0 ins.; mean displacement 832 tons; tons of water on board, 81; weather, clear and warm.

TIME.	No. of Card.	REVOLUTIONS PER MIN. Port.	REVOLUTIONS PER MIN. Starboard.	PRESSURES. Steam.	PRESSURES. Receivers Port.	PRESSURES. Receivers Starboard.	Vacuum.	Port Engine I.H.P.	Starboard Engine I.H.P.	Total I.H.P.	Rev. Per Min. Circulator.	DOUBLE STROKES PER MIN. OF PUMPS. Air.	DOUBLE STROKES PER MIN. OF PUMPS. Feeds.	WATER TEMPERATURE. Sea.	WATER TEMPERATURE. Discharge.	WATER TEMPERATURE. Hot Well.	WATER TEMPERATURE. Feed.	AIR TEMPERATURE. Outside.	AIR TEMPERATURE. Engine Room	AIR TEMPERATURE. Fire Room	Remarks.
																					Miles P. Hr.
Down	1	110	109.5	110	12	12½	23½	360.8	367.5	728.3	220	50	18	72	93	100	120	82	96	89	
5.44		(Mean	109.7)																		10.46
Up	2	118	116.5	103	10½	10	23½	348	361	709	260	48	18	73	93	98	110	82	96	80	
4.0		(Mean	117.25)																		15.0
Down	3	74	95	120	10	6	24	83	269.5	352.5	300	58	20	72	84	102	220	72	94	86	
7.12		(Mean	84.5)																		8.33
Up	4	74	99	150	10	9½	22	72.9	312	384.9	230	39	24	72	88	86	95	88	94	84	
4.34		(Mean	86.5)																		13.13
Down	5	102	100	140	11	11	23	317	311.5	628.5	240	37	19	72	94	104	200	72	91	88	
5.53		(Mean	101)																		10.19
Up	6	110.5	107	142	11	11	23	349.5	342	691.5	250	38	20	..	94	112	160	75	..	..	
3.59		(Mean	108.7)																		15.06
Down	7	116	115	149	17	17	23	434	448	882	250	39	22	73	110	120	140	75	..	..	
5.02		(Mean	115.5)																		11.92
Up	8	117	114	145	17	17	22½	428	435	863	260	38	18	72	99	110	180	..	..	..	
3.54½		(Mean	115.5)																		15.35
Down	9	118.5	116	150	19	19	22½	453	446	899	..	..	..	..	....	....	....	..	..	..	
4.51		(Mean	117.2)																		12.37
Up	10	119	117	149	18	18	22½	468	454.2	922.2	250	38	21	73	100	106	200	..	..	..	
3.54		(Mean	118																		15.38
Down	11	119.5	116.5	145	17½	17½	22¾	482	458	940	...	..	..	..	...	...	..	..	..	..	
4.45		(Mean	118)																		12.63
Up	12	119.5	116	145	17½	17½	22¾	466.5	448	914.5	250	39	20	73	100	104	210	..	..	..	
4.07		(Mean	117.25)																		14.57

NOTE.—L. P. linked up 1" on all runs.

pendent circuit and switch, and the forward capstan being connected on the circuit to the winches.

There is installed forward on the main deck, just aft of the hawser pipe openings, a 7 by 6-inch vertical combined steam and pump brake windlass of the Hyde Company's make, with double bits and special auxiliary shaft for quick speed of the gypsy heads. The windlass and engine are galvanized throughout, and a friction band and locking gear are provided. There is a heavy 9½-inch cast steel sprocket between each gypsy head and bearing, with a friction clutch suitable for operating messenger chains to the winding-in cable drums.

The table shown in Fig. 9 gives full account of the standardization runs that were required by the Government, while the speed curves and slip of propeller are shown in Figs. 10 and 11.

MACHINERY AND PIPING ARRANGEMENTS—III.

BY JOHN M'COLL.

In beginning a piping arrangement, the usual procedure is, first, to fix the number of views of the machinery and machinery space required to show clearly all the pipes and fittings, then to arrange these views to the best advantage on the drawing paper and drawing boards available. In ordinary merchant ships these views will include at least a plan and a profile the whole length of engine and boiler rooms, showing part of the tunnel, if that is used for refrigerating machinery, a section in way of the engine room and one in way of the boiler room. Shipside views, showing the auxiliaries, sea suction and overboard discharge valves, etc., are usually added. For twin-screw vessels the profile or elevation should show the engines and boilers looking to the starboard side; that is, looking on the back of the starboard engine and on the starboard boiler. A separate shipside view of the engine room (omitting the engine) looking to port side will then be required. More sections and part views will certainly be needed for large jobs.

The scale most favored for arrangement drawings is ½ inch to the foot; ⅜ inch to the foot is sometimes used for large arrangements, and does very well. One-quarter inch to the foot is occasionally used, but cannot be recommended except for simple arrangements, and where most of the smaller pipes are to be made to place. Where, as in some cases, all pipes down to, say, 1½-inch bore, are to be ordered by sketch, and below that bore, by giving approximate lengths and where the arrangement is likely to be complicated, ½-inch scale should if possible be adopted.

Having settled the number and arrangement of views to be given, the shipwork is first drawn in; then the engines, boilers and auxiliaries. It will depend on the method of carrying on the job how much of each of these items is shown in at the beginning. One of two methods may be taken. The main systems, that is, the steam and exhaust, suctions and discharges, and bilge and ballast arrangements, may be drawn complete on tracing paper or cloth, and all pipes and fittings ordered from these tracings before putting any part of them

NAME OF AUXILIARY	STEAM					EXHAUST					SUCTIONS											DISCHARGES										
	BOILERS DIRECT H.P.	BOILERS DIRECT REDUCED	AUXILIARY SYSTEM H.P.	AUXILIARY SYSTEM REDUCED	AUXILY SYSTEM CONTROLLED	MAIN CONDENSER	AUXILIARY CONDENSER	ATMOSPHERE	MAIN CONDENSER DIRECT	AUXILIARY CONDENSER DIRECT	SEA	HOTWELL	BALLAST TANKS	BILGES	BILGES DIRECT	RESERVE TANK	BOILERS	MAIN CONDENSER	AUXILIARY CONDENSER	FILTERS	FLOAT TANK	FRESH WATER TANKS	MAIN BOILERS	AUXILIARY BOILERS	FLOAT TANK	FILTERS (THROUGHOUT)	FEED WATER HEATER	MAIN CONDENSER OVERBOARD	AUXIL'Y CONDENSER OVERBOARD	OVERBOARD DIRECT	BALLAST TANKS	SANITARY TANK	FRESH WATER TANKS DECK	DECK. & FIREMAIN	ASH EJECTORS	DISTILLERS
MAIN CIRCULATING PUMP			(1½)						(2)		(12)				(8)													(12)								
AUXIL'Y CIRCULATING PUMP				○						○	○																		○							
MAIN AIR PUMP			○			○	○	○										○																		
AUXILIARY AIR PUMP				○		○	○	○											○																	
MAIN FEED PUMP			○		○	○	○	○				○				○	○			○	○		○	○			○								
AUXILIARY FEED PUMP			○	○	○	○	○	○			○	○				○	○			○	○		○	○			○								
BILGE PUMP				○		○	○	○			○			○	○															○		○		○		
SANITARY PUMP				○		○	○	○			○		○																			○		○		
FRESH WATER PUMP				○		○	○	○								○						○											○			
BALLAST PUMP				○		○	○	○			○		○	○	○													○	○	○	○					○
ASH EJECTOR PUMP	○					○	○	○			○																							○		
GENERAL SERVICE PUMP			○			○	○	○			○	○	○			○						○		○					○		○	○	○			
FEED HEATER			○									⊗ Drain																							
FEED FILTER																																			
DYNAMO ENGINES		○					○	○	○																										
STEERING ENGINE		○				○	○	○																											
ASH HOIST ENGINE				○		○	○	○																											
EVAPORATOR			○						⊗	Vapor																									
EVAPORATOR PUMP				○		○	○	○																											
FORCED DRAFT FANS	○					○	○	○																											
REVERSING ENGINE	○								○																										
TURNING ENGINE				○		○	○	○																											
REFRIGERATING PLANT				○		○	○	○																											
WINCHES				○				○		○																									

FIG. 14.

on the drawing proper. On the other hand, each system may be roughed out fairly accurately on tracing paper, put carefully into the main drawing, and the material ordered from the drawing. In any case, the drawing when completed should show all the pipes and fittings as finished in the ship. Notes should be taken during the progress of the work in the ship, and corections made, so that should replacing or renewals be required the drawing can be referred to with confidence. The bilge and ballast system need not be shown in the main drawing, as since this is about the first engineering work to be done on board, the arrangement has to be finished separately and sent out early. Further, the ship's engineers are supplied with

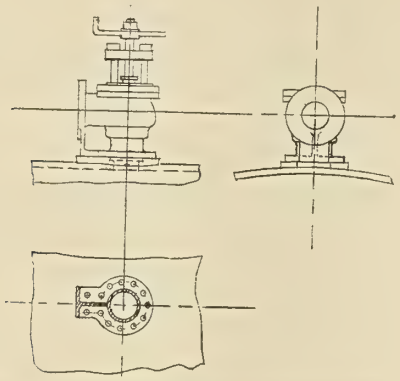


FIG. 15.—BOILER-STOP VALVE FOR MAIN STEM.

prints of the arrangement, and these are usually framed and hung up for reference in the engineers' mess room.

Before anything is done in planning pipes, etc., a diagram of "auxiliaries' connections" should be made out, as shown in Fig. 14. This will show at a glance what is proposed, and after approval what is being done. The connections and work of each pump may be clearly laid down in the specification, to ensure that certain duties will be done; but there may be another way than that specified for doing the same duty, which will at the same time simplify and reduce the number of connections and fittings. Reasonable suggestions to that effect are listened to, and may result in a saving to owner and builder.

Assuming that all requirements have been provided for, as shown in the diagram, the main steam pipes may come first for arrangement. Independent of the material or details of the pipes, the main leads should always have a slope, either up from the boilers to the engines or down from the boilers to the engines. The branch pipe from each boiler usually has to rise, but in any case water pockets are to be avoided, and each stop valve should be fitted with a drain valve. Lap-welded iron or solid drawn-steel pipes are the materials usually employed for the main steam pipes to the exclusion of copper. They are cheaper and stronger than copper pipes for the higher pressures, as copper loses much of its strength at the higher temperatures, due to the higher pressures.

The next point to consider, when the draining has been arranged, is the method to be used for taking up the expansion. Up to 6-inch bore bends may be used, but they should be more than a simple right-angle bend, unless the straight parts are long, otherwise expansion boxes are necessary. Where the pipes are large the stop valves on the boilers should be specially anchored. If a direct thrust is given, a wrought iron stay behind the valve should be fitted, or a bracket cast on at the back; but where the tendency of the expanding pipe is to twist the valve round, the flange joining the boiler should be extended below the pipe flange, as shown in Fig. 15. Expansion boxes are usually made of cast iron or cast steel for the larger sizes, with brass sleeves, glands and neck rings. In the smaller sizes the neck ring may be omitted, and the gland made of cast iron. An arrangement having bends only is shown in Fig. 16, and a combination of bends and expansion boxes is shown in Fig. 17.

In fixing the bore of the branch pipes from boilers to mains, the speed of the engines has to be considered, since if they are of the fast-running type, slightly increased areas should be given than would be used for slower engines. For ordinary slow-running engines the area of the main steam pipe to the engine is multiplied by 1.2 and divided by the number of boilers supplying that engine. In both cases the intermediate branch pipes should be ample, better rather more than the exact proportion.

The supply of steam to auxiliaries is usually taken indirectly from any boiler, and directly from two or more, preferably from those nearest the engine room. To determine the bore of the auxiliary steam pipe, make a list of those auxiliaries working steadily at sea, and a list of those working in harbor; combine the area of their steam pipes in each list separately and take the greater. The area may be further reduced, because there is less friction in one large pipe than in the smaller pipes for the same total area. The proportion taken may be

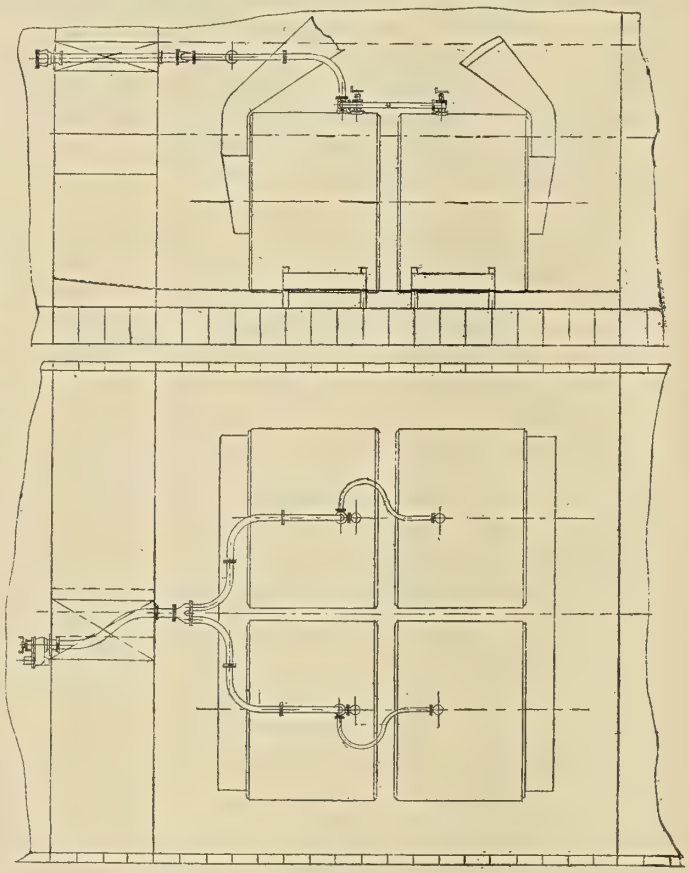


FIG. 16.

.8 of the combined small pipes. The size of the auxiliaries' main exhaust pipe may be found in the same manner. The auxiliaries' steam supply is usually divided into two ranges, as some work with full boiler pressure and others with reduced pressure. In these cases advantage should be taken in determining the bore of the auxiliary main of the increased volume of steam gained in reducing from the high to the lower pressure. As in the main steam line, the auxiliary system should slope one way and be without pockets. This may imply that the last auxiliary on a range of piping will receive the drain, but suitable provision can be made for that.

While it is not necessary to have a stop valve where the supply to each auxiliary leaves the main, it should be arranged that at least both sides of the engine room be independent, so

that should the supply to any one auxiliary have to be shut off, the whole engine room may not be involved. The same applies to the deck machinery. Those auxiliaries forward of the engine room should be independent of those aft. Stop valves and branch pieces for steam and exhaust will be to specification; but where the material is not definitely stated they can safely be made of brass up to 1¾-inch bore, and above that of cast iron, and as a rule has to be made for branch pieces, make all those with a 2-inch bore branch in them of cast iron. Steam branch pieces should have if possible the smaller branch inclined upwards, or be so arranged that the pipe comes from the top of the piece. Exhaust branch pieces should have the branches inclined, that the flow of steam will be in the direction of the main flow. Cocks should not be used where valves will serve, and care ought to be taken that the exhausts from fast-running engines are not controlled by cocks. The main feed pumps are supplied with high-pressure steam, controlled by a float tank, or heater float, for use at sea, and also supplied direct from the main system for use in harbor, or in case the float gear should be out of action. The auxiliary feed pump is also supplied with high-pressure steam, but if doing other duties besides supplying the boilers, should also have a supply of reduced steam. A non-return valve will be needed to prevent the high-pressure steam getting into the low-pressure system.

Where the exhaust steam is not used to heat the feed water it may go to the condenser or atmosphere, but the exhaust from the auxiliaries using high-pressure steam is of some value, and should be made use of in the low pressure or other receiver. The dynamo engines should have their steam and exhaust pipes quite separate from the other auxiliaries, and in addition should have a steam separator fitted. Indeed, all reasonable means must be taken to ensure steady running and steady light, as more trouble is caused through complaints about flickering lights than through more serious inconveniences.

Steam pipes and fittings should be kept clear of the switchboard, so that drips and undue heat may be avoided. The steam supply to the steering engines is, by rule, kept independent of the supply to other auxiliaries. Where the distance is considerable and if there is much variation in the level of the piping a drain trap should be fitted at the lowest point. This will apply also to the exhaust piping.

The steam supply to galleys and heating systems, especially the galleys, is most important in some cases, and care has to be taken that no interruption takes places in the supply of these, even should other systems fail.

The exhaust or drains from the heating systems and galleys should be led along with the other drains to the hot well or float tank, that they may be passed through the filter. On long-voyage ships the saving of water becomes of importance, and an efficient drain system will be a great advantage.

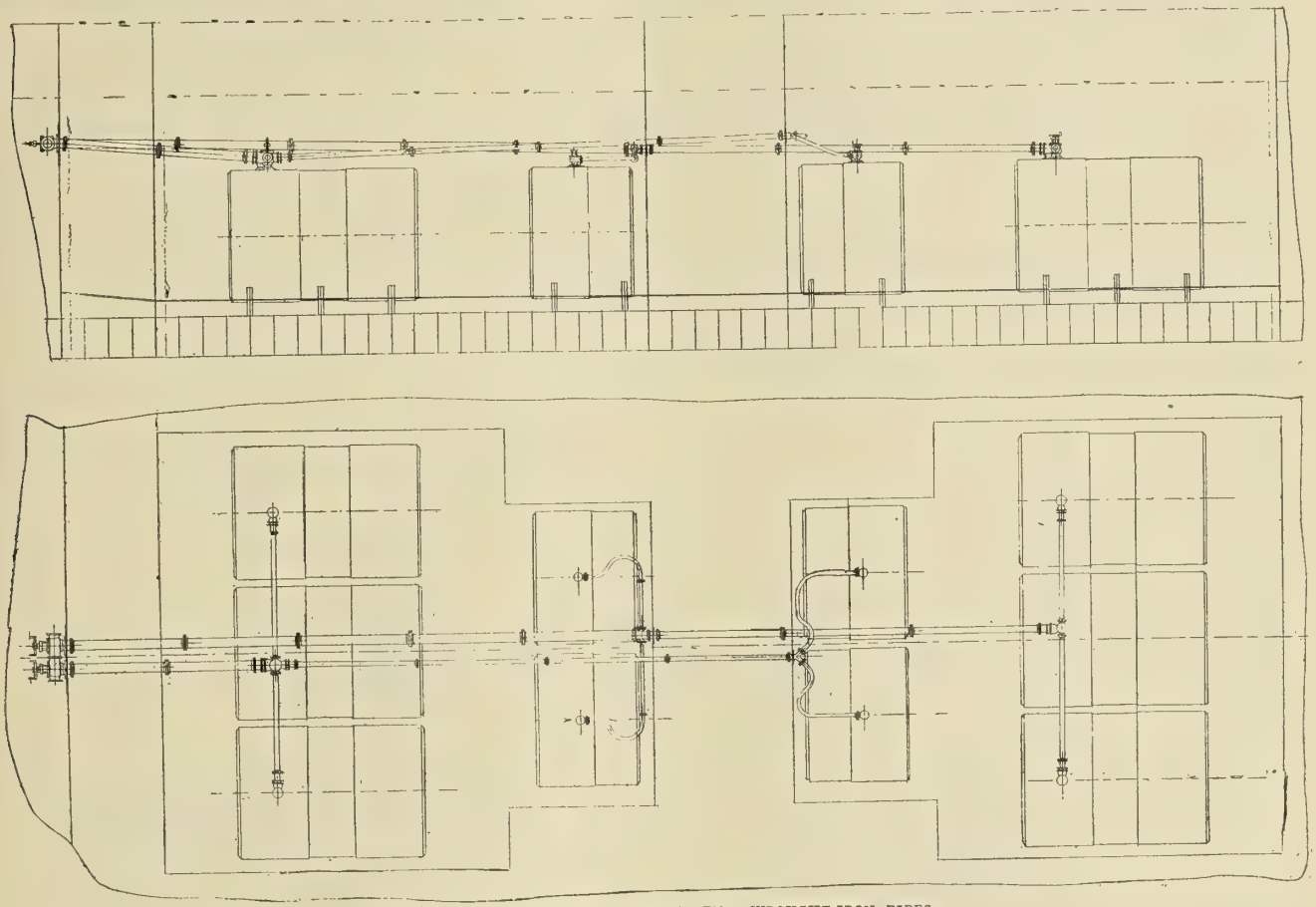


FIG. 17.—MAIN STEAM-PIPE ARRANGEMENT, WROUGHT-IRON PIPES.

THE MARINE STEAM ENGINE INDICATOR—VI.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

PIPES AND COCKS.

A suitable indicator having been selected, it now becomes necessary to consider the matter of attaching it to the engine. If this is not properly done the precision of the best instrument will be of no advantage, and all the cards obtained will be untrustworthy. It is safe to say that all propelling engines of any considerable size are fitted with indicator connections and reducing motions, and on many of the auxiliaries drilled and plugged holes will be found which are intended for indicator cocks. The sea-going engineer should not take it for granted, however, that these holes are properly located or that

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the pipes and reducing motions cannot be improved. The designers and builders are not infallible, and probably in five cases out of ten they give less attention to the indicator appliances than to any of the other engine details.

If the engine to be indicated is not provided with connections, the whole arrangement should be worked out, sketched and dimensioned before a tool is touched. It is much easier to rectify errors on paper than it is to correct mistakes in metal working. The holes for the cocks should be located so that they will not be even partially closed by the piston when the engine is on the center. If necessary, short channel ways should be chipped in the cylinder cover, or cylinder bottom, of sufficient depth to maintain the full area of the pipe. The idea

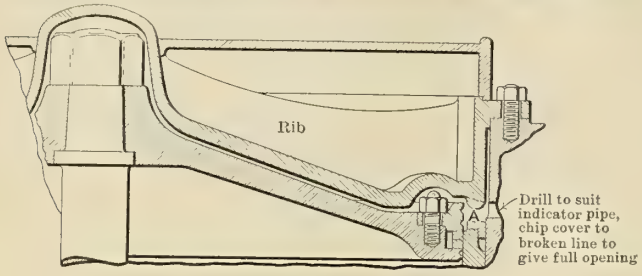


FIG. 43.

is shown in Fig. 43. The space *A* in the figure exceeds the area of the pipe, but part of the steam in flowing to and from the indicator is forced to turn through 90 degrees, and wire drawing, to a greater or less extent, is sure to result. When cutting channels it should be borne in mind that the cylinder covers and bottoms of moderate-size engines are either cored out or ribbed, and that the metal is seldom over 1⅜ inches thick.

In order to obtain a full and free passage to the indicator the holes for the pipes or cocks are sometimes tapped into the passages leading to the steam ports. This is the worst possible location on the whole casting. If the holes are partly closed at the end of the stroke, the diagram drawn by the instrument will be affected at the ends only, but with the instrument connected to the steam passages—or even near them—the steam and exhaust lines will be untruthful, and the horsepower shown on the card will be made lower than the actual power developed.

The writer remembers the case of a steamer whose contract called for some 8,000 indicated horsepower and 17 knots speed.

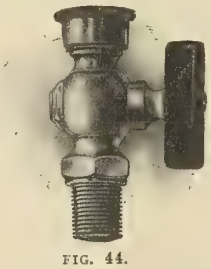


FIG. 44.

On the preliminary trial the vessel made the required speed but only about 7,000 horsepower. This was a serious matter, as a heavy penalty had been prescribed in case of a failure to show the required power. As the engine had made the designed number of revolutions the indicators were suspected, and an expert was called. He found the indicator pipes tapped into the steam passages. The pipes were relocated in correct positions. On the official trial, with the same revolutions as before, the builders earned a premium for developing more horsepower than the specifications required.

It is also bad practice to locate the pipes directly opposite the steam ports, particularly in small, quick-turning engines, as the steam has more or less inertia, and is liable to cause a false reading, especially if the indicator connection is short and direct. The best position for tapping the hole is about 100 degrees from the center line of the ports. Pipes taking steam at this point are less liable to have the pressure in them affected by steam current and eddies. This position may, of course, be modified to suit the cord-lead from the reducing motion, as guide pulleys are objectionable; but the holes must be kept clear of the ports at all costs.

When drilling holes it is always best to remove the pistons and make a proper job, but if this cannot be done the engine may be shored, so that it cannot move, and about 5 pounds pressure put on the cylinder. The pressure may be judged by opening the drain, or it may be known accurately by attaching

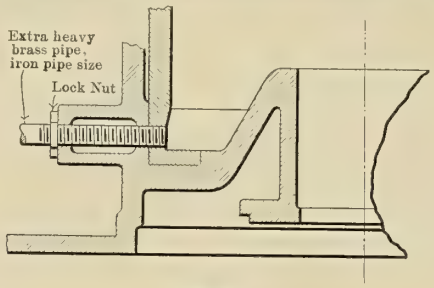


FIG. 45.

a gage outside of the drain valve on the end of the cylinder which is being drilled. The moment the drill point pierces the cylinder wall the jet of issuing steam will blow the hole clear, and will keep all borings out of the cylinder itself.

The centers of the holes having been located, the layout of the cocks and pipes should be taken up. When accuracy is of importance, a pair of instruments must be used, each instrument being connected to a cock similar to Fig. 44, which has been screwed directly into the hole drilled in the cylinder casting, or into a straight pipe, just long enough to clear the lagging. Fig. 45 shows such a pipe attached to the bottom end of a steam-jacketed cylinder. Unless the indicator is of the

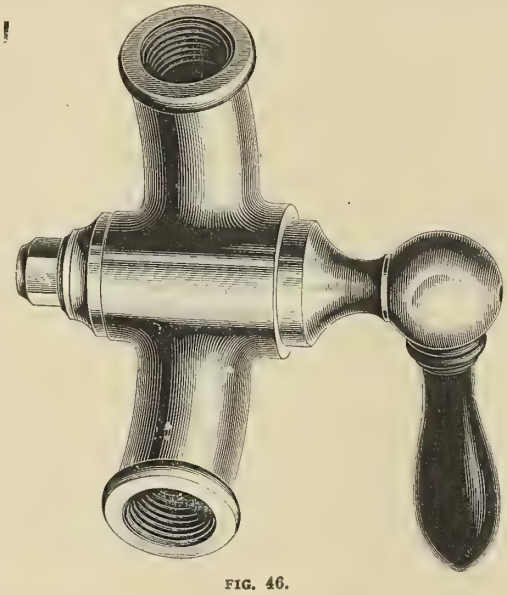


FIG. 46.

type shown in Fig. 37 (December, 1909, issue) this connection will bring the indicator drum-axis in a horizontal position. The manipulation of an instrument attached in this manner is somewhat unhandy, but the increase in accuracy is worth the trouble. The next best thing is to use a cock of the type shown in Fig. 46.

If two indicators for each cylinder are out of the question, the side pipe and three-way cock (Fig. 47) must be used. This cock is made especially for marine engines, and is fitted with

1-inch pipe connections. No important deductions should be made from an indicator connected up in this manner, as the diagrams are inaccurate, especially if the stroke of the engine is long. On engines running with a steady load, such as a dynamo engine driving a ship's lighting plant, a very good correction can be computed by taking a diagram from each end of the cylinder with a short direct connection, and then

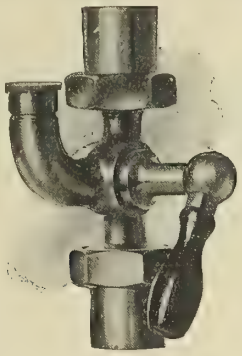


FIG. 47.

taking a set with the three-way cock and side pipe, and the difference noted. If this operation is attempted, care should be taken to have the steam, voltage and current the same when the cards are taken. In the case of small engines, the pipes should not be over ½ inch inside diameter, because the pipe adds to the volumetric clearance, and this in turn distorts the diagram. On large engines the pipes may be increased to 1 or 1¼ inches inside diameter with advantage, as such pipes tend to do away with friction and do not sensibly affect the clearance volume.

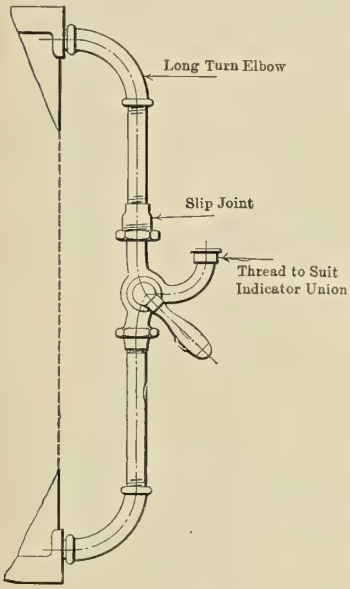


FIG. 48.

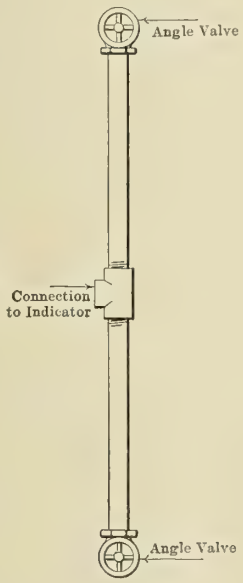


FIG. 49.

The arrangement should be about as shown in Fig. 48, the bends being as long and easy as practicable, and the cock located in the middle of the length of pipe. The arrangement illustrated in Fig. 49 is particularly bad, and should never be used. Either one of the angle valves may leak or be left partly open, and in any case the entire pipe has to be filled at each revolution. A diagram taken with this form of connection will indicate large clearance, deficient lead and obstructed steam ports when these defects do not exist. Brass pipe should be used in fitting up. The burrs caused by the pipe cutter should be removed with a reamer, and red lead paint and other kinds of pipe "dope" omitted. A small particle of hardened red lead or other foreign substance on the indicator piston will sometimes cut queer figures on the diagram. Oil should be used in making up the joints, and if the leaks persist they can be easily stopped by winding a strand of cotton waste in the pipe thread. The pipes and cocks should be blown through with live steam, both before and after connecting up, and the openings kept carefully plugged or capped after the job is completed.

(To be continued.)

THE U. S. COLLIERS MARS, VULCAN AND HECTOR.

On May 13, 1908, the United States Congress appropriated $1,575,000 to buy three colliers, with a cargo-carrying capacity of approximately 7,200 tons dead weight each. The Secretary of the Navy being authorized to make the purchase, issued a circular stating the particular features required and the maximum time of delivery, asking for bids to be opened on June 1, 1908. The Massachusetts Steamship Company and several ship-building firms offered to furnish these boats, the Massachusetts Steamship Company being the only bidder who had the ships built and could deliver them immediately; the others were to construct them. These bids were all thrown out on the ground that they did not meet with the requirements of the circular and new bids asked. These were opened on Sept. 1, 1908. The Maryland Steel Company was the lowest bidder offering to build the three ships for $1,138,800 and to deliver then in ten, eleven and twelve months. These ships, the *Mars, Vulcan* and *Hector,* have just been delivered to the government by the above company after having satisfied the requirements of the contract.

They are single-decked self-trimming vessels, with poop bridge and forecastle, with a pilot house above the bridge, two masts and ten derrick posts; each having two booms, arranged to lift hatch covers and to handle cargo. There are ten large hatches with steel covers, especially fitted to be water tight. A double bottom runs from the after boiler room bulkhead to the forward peak bulkhead, and upper wing ballast tanks are formed in the triangular space between the deck and the side, outboard of the cargo hatches. The machinery space, containing four Scotch boilers, two triple-expansion engines and auxiliaries, is placed aft. The bunker coal is carried in longitudinal bunkers abreast the boilers and on the main deck around the boiler casing. A donkey boiler is located on a flat forward in the boiler room. Fresh-water tanks are in the engine room, while a refrigerating plant is located on the main deck aft. The officers' quarters are in the bridge house, the engineer's in the after-deck house on the poop deck, and the crew on the main deck aft. The forecastle contains the windlass engine and storerooms. The hull and machinery are constructed in accordance with the requirements of the American Bureau of Shipping for their highest class.

THE HULL.

The principal dimensions are: length between perpendiculars, 385 feet; length over all, 403 feet; beam molded, 53 feet; depth, 32 feet 6 inches; draft, 24 feet 6 inches; speed, loaded, 12 knots. The upper stem is bar steel and the lower cast steel, efficiently connected to the forward keel plate; the stern post is cast steel of channel section, with an opening for the propellers, and extends into the hull to efficiently connect with the keel plate. Hangers for the shafts are bolted to the main piece. The rudder is of the built-up type of wrought steel, connected to a 10-inch diameter extension stock by a flanged coupling bolted, the weight being taken by a bearing on the main deck.

The keel is a flat plate 36 inches by 35 pounds, the center keelson 22 pounds 48 inches high, connected to the keel plate by double angles 6 inches by 4 inches and to the tank top by

THE COLLIER MARS.

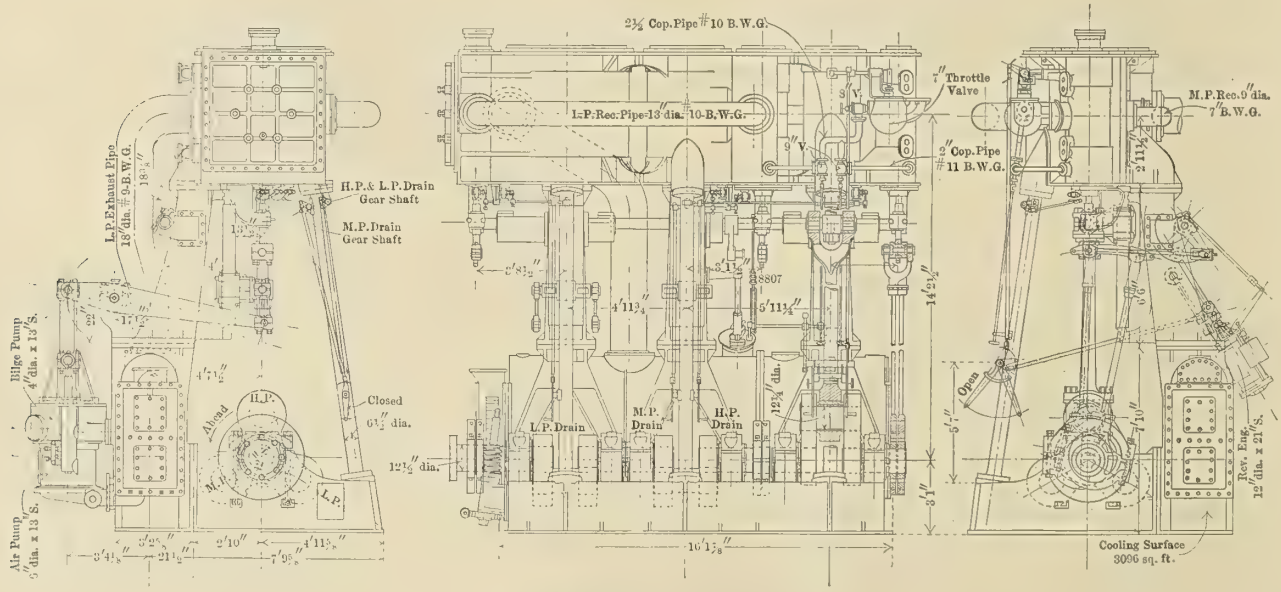
4-inch by 4-inch angles. The frames in the water bottom are 3½-inch by 3½-inch angles, between the margin and top side tanks 10-inch by 3½-inch channels split at the bilges, and bracketed to the top side tanks, at the ends they are 8-inch by 3½-inch bulb angles, in one piece from center line to deck, in the top side tanks 7-inch by 3½-inch angles, in way of erections 6-inch by 3½-inch angles, and the bulkhead frames are double 3½-inch by 3½-inch angles; all spaced 26 inches. The reverse frames are 3½ inches by 3½ inches by 10 pounds by 9 pounds in one piece from center line to margin, double in the machinery space.

There are solid floors on every frame 18 pounds to 15 pounds at ends, increased in the machinery space. Two intercostals are on each side of the center line, 17-pound plates amidship to 15-pound plates at the ends, they have large lightening holes and the necessary limber and air holes.

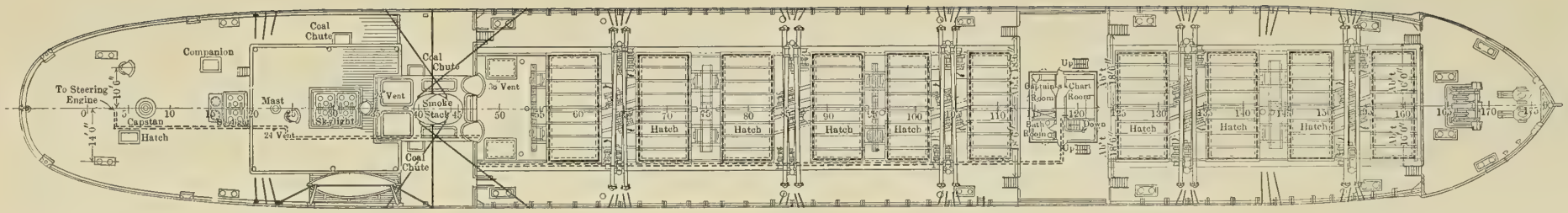
The tank tops, 19 pounds amidships to 16 pounds at the ends, with the butts lapped and double-riveted seams, single-riveted in the cargo spaces, the hold ceiling of 2½-inch yellow pine is laid on 2½-inch yellow pine battens.

The margin plate is 19 pounds amidships to 17 pounds at the ends, fitted in a straight line between butts. The top side-tank stiffeners are 7-inch by 3½-inch angles, the ties 6 inches by 3½ inches and the plating 17½ pounds. Two side stringers are fitted built of 10-inch by 3½-inch channels, with 20-pound intercostal plate. The shell is built on the clinker system on the bottom and in and out on the sides; the bottom is 24 pounds, the bilge 26 pounds, the sides 24 pounds and the sheer 26 pounds, all reduced at the ends, the sheer strake retaining the same thickness through the machinery space.

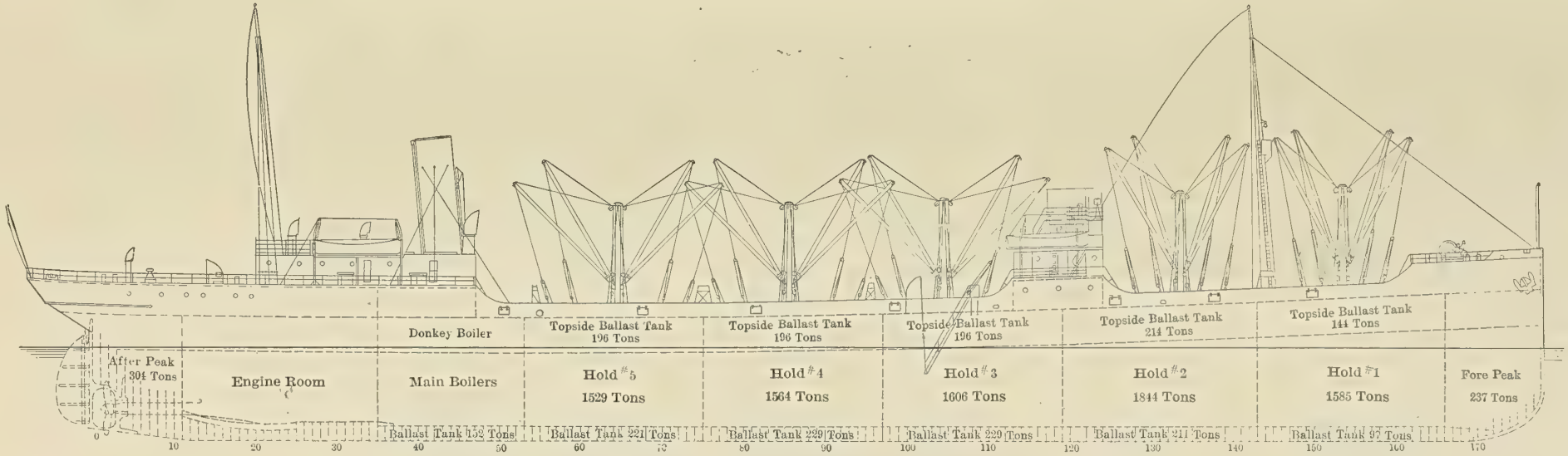
A bilge keel of 10-inch bulb angle and 3½-inch by 3½-inch angle extends throughout the parallel portion of the hull. The main deck stringer is 66 inches by 25 pounds, the plating is 17 pounds, both reduced at the ends, and the beams are 12-inch channel, spaced on alternate frames. In way of hatch openings they are 8-inch by 3½-inch channels on alternate frames, with 7-inch by 3½-inch intermediates. There are seven bulkheads, which divide the ship into eight water-tight compartments, built of 17 to 14-pound plates stiffened with vertical flanged plate and 10-inch bulb angles bracketed top and bottom. Also there is one non-water-tight bulkhead between the engine and boiler rooms. The forecastle bridge and poop in general are constructed of 15, 16 and 14-pound stringers, 12 and 14-pound plating, and beams of 7-inch by 3½-inch and 10-inch by 3½-inch channels. The hatch coaming is 21-inch by 20-pound plate attached to an 18-inch plate that forms the inner end of the top side tank, making a total height above deck of 39 inches.


L.P. Exhaust Pipe 18" dia. #9 B.W.G.
H.P. & L.P. Drain Gear Shaft
M.P. Drain Gear Shaft
Bilge Pump 4" dia. x 13" S.
Air Pump 9" dia. x 13" S.
Ahead
Closed 6½" dia.
12½" dia.
2¼ Cop. Pipe #10 B.W.G.
L.P. Rec. Pipe 13" dia. #10 B.W.G.
3" V.
1" Throttle Valve
2" Cop. Pipe #11 B.W.G.
M.P. Rec. 9" dia. #7 B.W.G.
L.P. Drain
M.P. Drain
H.P. Drain
12¾" dia.
Open
Rev. Eng. 12" dia. x 21" S.
Cooling Surface 3096 sq. ft.

MAIN ENGINES OF THE MARS.

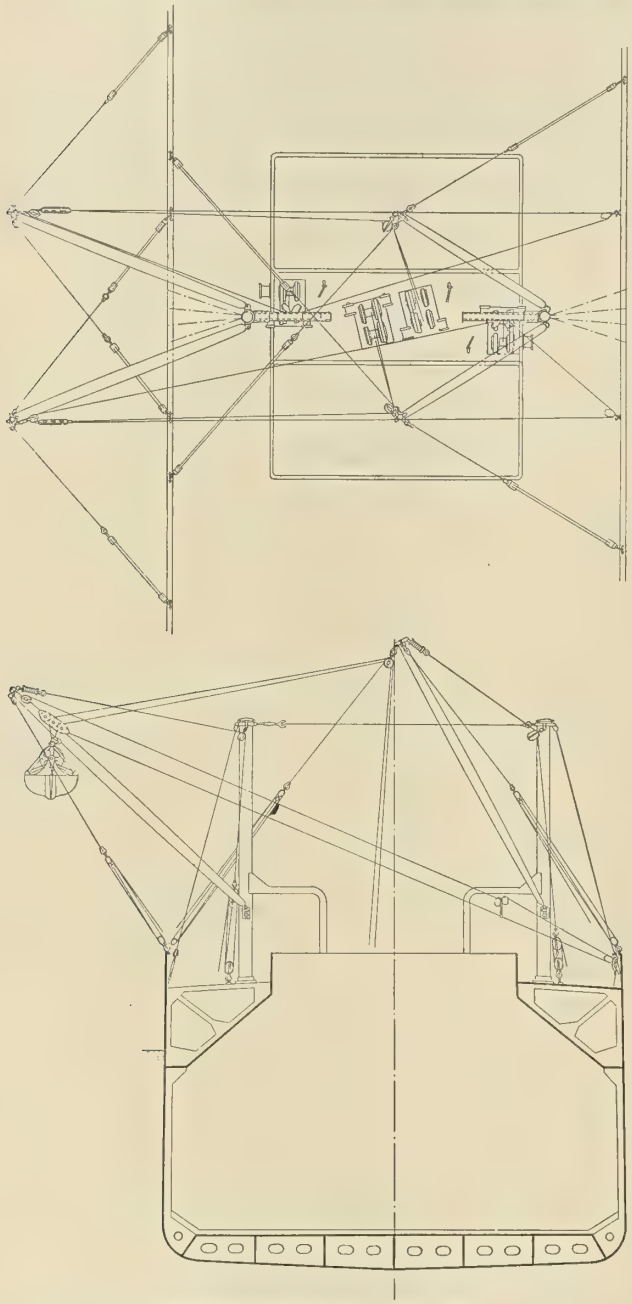


DECK PLAN OF THE MARS, SHOWING ARRANGEMENT OF HATCHES, CARGO BOOMS AND WINCHES.


After Peak 304 Tons
Engine Room
Donkey Boiler
Main Boilers
Topside Ballast Tank 196 Tons
Topside Ballast Tank 196 Tons
Topside Ballast Tank 196 Tons
Topside Ballast Tank 214 Tons
Topside Ballast Tank 144 Tons
Hold # 5 1529 Tons
Hold # 4 1564 Tons
Hold # 3 1606 Tons
Hold # 2 1844 Tons
Hold # 1 1585 Tons
Fore Peak 237 Tons
Ballast Tank 152 Tons
Ballast Tank 221 Tons
Ballast Tank 229 Tons
Ballast Tank 229 Tons
Ballast Tank 211 Tons
Ballast Tank 97 Tons
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170

INBOARD PROFILE OF THE MARS, SHOWING ARRANGEMENT AND CAPACITIES OF HOLDS AND TANKS.

One of the most important features of a vessel of this class is the coaling gear. These colliers are fitted with the Lidgerwood Miller marine transfers. The decision of the Navy Department to equip the colliers with this gear was reached after the contract for the ships had been let to the Maryland Steel Company. Before the winches were selected for the colliers *Vestal* and *Prometheus* a competitive test was held in the New York Navy Yard between a very fine winch with wood and iron frictions, built at the Norfolk Navy Yard,



ARRANGEMENT OF COALING APPARATUS.

and a new type of winch, offered by the Lidgerwood Manufacturing Company, of New York.

The introduction on board ship of machinery to operate a clam-shell bucket (thereby dispensing entirely with the shoveling of coal in the hold) was new, and no ship's winch has ever been designed or constructed for this purpose. Deck space is valuable and limited, and the winches designed by the Lidgerwood Manufacturing Company occupy a space of only 7 feet 8 inches long by 5 feet 10½ inches wide. These winches have only 8¼-inch by 10-inch cylinders and yet they have proved capable of handling a 1⅝-cubic yard load (one gross ton of coal) with perfect ease and with an ample factor of safety. In shore coaling towers 10-inch by 12-inch cylinders are the smallest that are ever used with this bucket. Wood and iron friction drums are employed on shore towers very extensively and with success, but there is room there for them and they are of very large diameter, even 40 inches, 50 inches and 60 inches in some instances. The deck space available on the colliers limited the diameter of the frictions to something like 24 inches and the Lidgerwood Company regarded the use of wood and iron frictions as impossible for this service. Even their metallic frictions provided with air-cooling passages got extremely hot in the course of a run of one hour's duration. In the test at the New York Navy Yard the wood and iron frictions, in three hours' running, were rendered unfit for further service, having ¼ inch of charcoal on the wood.

The winches having been adopted for the *Vestal* and *Prometheus,* and the Lidgerwood Company standing ready to guarantee an output of 100 tons of coal per hour per hatch if the same system was installed on the colliers *Mars, Vulcan* and *Hector,* the Navy Department, therefore, decided to adopt them, and a subsequent contract was made with the Maryland Steel Company. The Lidgerwood Company was under a penalty of three hundred dollars per ton for each ship for every ton less than 100 handled from each hatch. Coal to the amount of 117 tons was discharged from one hatch on the *Mars* in one hour; 170 tons from the *Vulcan* and 190 tons from the *Hector.*

There were three important points not ignored by the Lidgerwood Company in the design and construction of these winches. First, the employment of the metallic slip frictions with air-cooling passages; second, the employment of the lever control, which made the operation comparatively easy for the operator; third, the position of the operator was such that he could see the bucket in all parts of the hold as well as in every position it might take above the hatch. One operator attends wholly to the closing, hoisting and lowering of the bucket, while the other attends wholly and exclusively to the swinging of the same. The booms are fixed. The bucket operates in a curved line in a plane athwartships.

The extraordinary success of this coaling gear is undoubtedly the beginning of a revolution in coaling our ships. At the present time our battleships are equipped with winches, booms and tackle, so that the sailors on the battleships can hoist coal in bags from the colliers or barges alongside. It is an extraordinary fact, as stated by Admiral Dewey, that at the time the fleet started on its journey encircling the globe that the entire available supply of 4-inch manila rope in the market was exhausted. The chief bill for cordage for the Navy Department is for manila rope used for coaling ships. If now, the clamshell bucket is introduced on all of our colliers it is clear that coal may be delivered in bulk at various parts of a battleship. Therefore, the necessity for winches and booms, and also for rigging on battleships, will disappear, because it is clear that the problem will then be one of taking the coal from piles on deck and shoveling it either to the chutes that are nearest the piles or shoveling it into bags or baskets and dragging them across the deck to other parts of the battleship. In the old method, also, the sailors were sent into the hold to shovel coal into bags, and it is worthy of note that the old colliers seldom delivered more than 25 tons of coal per hour per hatch, and even that required from 20 to 25 men. The *Mars* can easily discharge 1,000 tons of coal per hour—the work of a thousand men—and only twenty men will be required to perform this. Those twenty men must be better than the ordinary grade of sailor and they must be well drilled, and that is one of the problems before the Navy Department. To place twenty well-drilled men on a collier will represent a considerable increase in the expense of the

collier service. On the other hand, if the sailors from the battleships are sent aboard the colliers, logically they will have to learn the art of handling these winches before they can attain the guaranteed or a better capacity. One suggestion has been made and that is that each battleship in advance of its coaling send men aboard the collier to learn the operation of the gear, for it is claimed that it requires only about two days' practice of men who have an aptitude for that sort of thing.

The main engines are of the vertical, inverted-cylinder type, having cylinders 22 inches, 37½ inches and 60 inches diameter by 42-inch stroke. The high-pressure cylinders are fitted with working liners and 9½-inch piston valves. The intermediate-pressure cylinders have 19-inch piston valves and the low-pressure cylinders have the usual double-ported slide valves. The cylinder heads are cast iron, with checkered-steel false covers. All the pistons are iron castings. The high-pressure and intermediate-pressure are fitted with followers and snap rings, the low-pressures are fitted with followers, bull rings and spring rings, set out by steel "C" springs. The piston rods are 5½ inches diameter in body and packed with metallic packing. The main-valve stems and throttle-valve stems are also packed with metallic packing. The connecting rods are steel of the forked type, 8 feet center to center, having hard brass boxes for the crosshead pins, and cast steel, white metel-lined boxes for the crank pins. The crosshead pins are 6½ inches diameter by 7¼ inches long. The guides of the bar type are iron castings fitted with water circulation and cast steel slippers faced with white metal. The front columns are polished steel 6½ inches diameter, and the back columns are cast iron resting on the main condensers. The bed plate is of a deep box section, cast iron, in one piece and has six main bearings fitted, each 13¾ inches long. Each bearing consists of a cast iron semi-circular bottom box, which rolls around the shaft to remove, and a cast steel cap. Both cap and box are lined with white metal. The crank shafts are of the built-up type 12¼ inches diameter, in one piece. The crank pins are 12¼ inches diameter by 13¼ inches long between webs. The high-pressure webs are 8½ inches thick, the intermediate-pressure are 8⅞ inches thick and the low-pressure webs are 9¼ inches thick. The valve gears are of the "Stevenson Link" type, having cast iron eccentrics and straps, and steel eccentric rods with cast steel yokes.

The reverse engines are straight steam rams, 12 inches diameter by 21-inch stroke.

The built-in type of main condensers are fitted, having a total cooling surface of 6,192 square feet. Each condenser contains 1,212 ⅝-inch diameter brass tubes, No. 16 B. W. G. thick, tinned inside and outside, and fitted with screw ferrules in rolled-brass tube sheets. An air pump and two bilge pumps are worked from each low-pressure crosshead. Each air pump is 26 inches diameter of bucket by 13-inch stroke, and each bilge pump has a 4-inch diameter plunger with a 13-inch stroke.

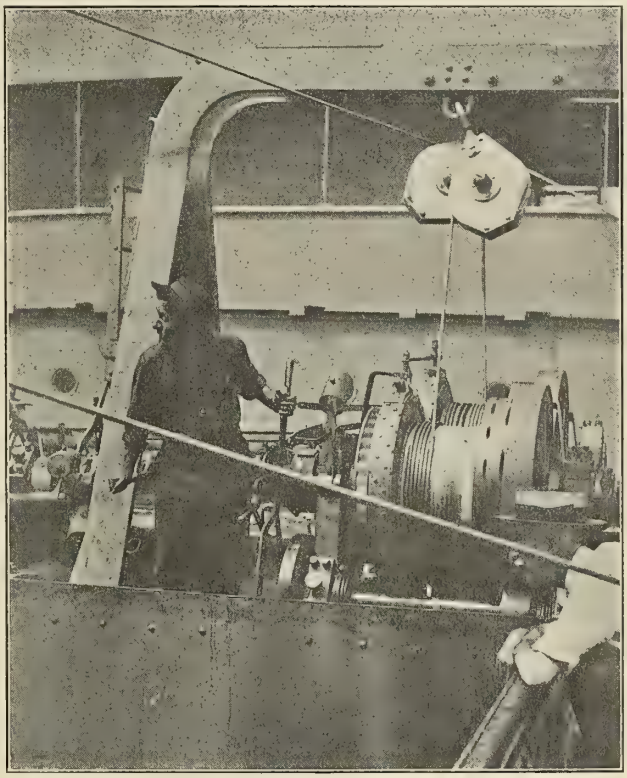
A double-cylinder 6-inch by 6-inch turning engine is located between the main engines just aft of the main bed plates, and connected to main shafts by double-worm gearing.

The thrust shafts are 12¼ inches diameter, each having eight 18-inch diameter collars. The shoes are cast iron, faced with white metal, and held in place on steel rods by brass nuts, permitting independent or collective adjustment. The whole block is fitted with water circulation.

As the main engines are well aft, there is only one piece of line shaft to each main shaft. These shafts are 11¾ inches diameter. The propeller shafts are 13 inches diameter, with brass sleeves throughout the entire length of the stern tube. The propellers are 14 feet 9 inches diameter and 14 feet 3 inches pitch, adjustable 3 inches either way. The hubs are of semi-steel, with cast iron caps. The blades are bronze.

There are four main boilers and one donkey boiler, built for a working pressure of 200 pounds per square inch. The main boilers are 15 feet diameter and 10 feet 9 inches long, designed and fitted for Howden's system of forced draft. The tubes are 2½ inches diameter, fitted with retarders. Each boiler contains three 44-inch inside diameter Morison flanged furnaces, with a combustion chamber to each furnace. The total heating surface is 10,200 square feet. The furnaces are fitted with cast-iron fronts, doors and grates 5 feet 4 inches long. The donkey boiler is a single-end Scotch, 8 feet diameter and 10 feet 6 inches long, having one 44-inch inside diameter Morison furnace.

The independent pumps consist of the following: Two vertical, simplex, main feed pumps, cylinders 14 inches, 10 inches by 24 inches; one vertical, duplex, auxiliary feed and fire pump, cylinders 10 inches, 7½ inches by 12 inches; one vertical, duplex, ballast pump, cylinders 12 inches, 14 inches by 12 inches; two vertical, duplex, fresh-water and sanitary pumps, cylinders 5¼ inches, 4¾ inches by 5 inches; one horizontal, duplex, evaporator feed pump, cylinder 4½ inches, 3¾ inches by 4 inches; one vertical, duplex, donkey boiler feed pump, cylinder 4½ inches, 2¾ inches by 4 inches, and two M. S. Company's make centrifugal circulating pumps, having 12-inch suctions and driven by vertical single 8-inch by 8-inch engines.



ONE OF THE LIDGERWOOD WINCHES INSTALLED ON THE MARS.

One 12-ton and one 5-ton Reilly evaporator, and one 15-inch Reilly distiller are also installed. A 36-inch Reilly feed-water heater and a 4-inch Blackburn-Smith grease extractor are fitted in the main feed lines. A Wheeler auxiliary condenser, having 1,000 square feet of cooling surface, is located in upper engine room. The two blowers for the forced-draft system are driven by vertical single 5-inch by 4-inch engines, and are also in the upper engine room. A 15-kilowatt Sturtevant direct-connected electric set complete, with switchboard, etc., has also been provided in upper engine room. A refrigerating plant of 800 cubic feet capacity is installed aft on main deck.

16,200 feet above sea level, in the mountains of Peru, are located the richest and largest mines of VANADIUM sulphide ores in the world. These mines are the property of the American Vanadium Company, and hold enough ore to supply the world's demand for VANADIUM ALLOYS. The picture shows a pile of Vanadium Patronite ready for shipment on the backs of llamas to the railroad, thence to port on the way to the refinery at Bridgeville, Penna.

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VANADIUM carries away oxides and nitrides in a fusible slag, leaving a dense, non-porous, homogeneous metal that will not crystallize under severe impacts, shocks and vibration. The increased strength permits the use of smaller members in machine parts; gives a higher factor of safety and greater durability wherever applied. For shafts, gears, piston rods, engine forgings, chains—for all parts that meet high duty and rigorous service—for the vital parts, VANADIUM steels have no competitor. Booklets with tests, analyses, types for various uses, and directions for application and heat treatment on request.

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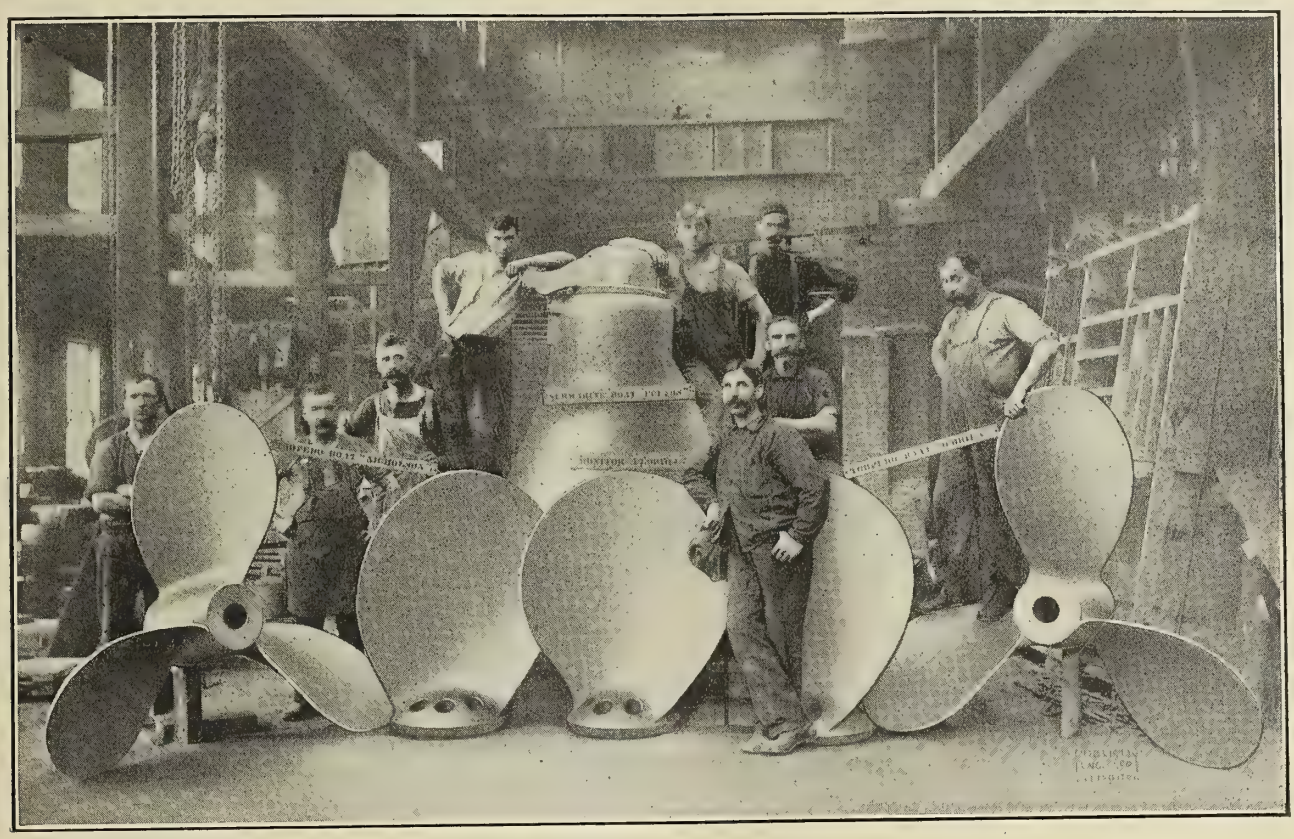

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TO THE MARINE INDUSTRIES:

We take this opportunity of notifying you that we have secured the secret processes of the Victor Metals Company.

The addition of Vanadium to Victor Bronze and Victor Non-Corrosive Silver Metal enables us to unhesitatingly claim the cleanest, toughest and strongest bronze composition that is practicable for marine service and the only non-corrosive and non-tarnishing metal with the tensile strength of high priced alloy steels.

Victor Bronze has been installed in every submarine vessel in the United States Navy, and has also been used in vessels of this class in Japan, Austria and Russia, because:

It is the strongest, cleanest and closest structured bronze.

It is lighter in actual weight than any other bronze casting of the same dimensions.

It is the only bronze casting that can be satisfactorily forged.

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	Ultimate Strength.	Elastic Limit.	Elongation in Two Inches.	Reduction of Area.
Castings	71,000 lbs.	28,500 lbs.	32%	27.8%
Plates, cold rolled	95,370 lbs.	76,940 lbs.	10%	14.9%
Rods, cold rolled	92,090 lbs.	80,070 lbs.	11.5%	29.3%
Wire	101,000 lbs.	83,180 lbs.	10%	31.8%

Write us for booklet on "Vanadium Metals in Marine Construction" and for quotations on castings up to 7,000 lbs., plates, rods, etc.

VANADIUM METALS COMPANY

FRICK BUILDING **PITTSBURGH, PA., U. S. A.**

Watch this page next month for description of non-corrosive metal

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

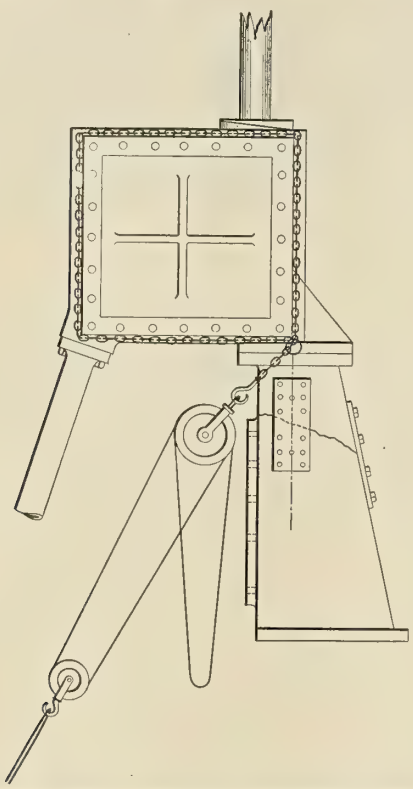
Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Fracture of a Back Column.

Some years ago, while a junior engineer on a vessel bound from Puget Sound to the Orient, rather an unusual accident happened to the engine. The captain was sailing the Great Circle course very late in the season, when, as Kipling puts it in McAndrew's hymn, "Fail there, ye've time to weld your shaft—ay, and eat it ere ye've spoke."

The engine was of the vertical compound-marine type. The back columns were of cast iron, resting on the condenser, and the front columns were turned wrought steel.

The accident happened just after midnight; the engines were racing, and the engineer on watch was standing by



ARRANGEMENT OF TACKLE AND BRACES TO SUPPORT FRACTURED COLUMN.

throttling the engine, when the vessel threw her wheel out of water. Shortly after taking the watch the second assistant noticed a bad knock in the low-pressure engine, shortly followed by the low-pressure crosshead and piston rod running hot. The engine was immediately slowed down and the chief called. Upon investigation the low-pressure back column was found to be broken off just above the crosshead guides, and the cylinder was jumping with every stroke of the engine. Before the engine could be stopped the other back column was in danger of breaking. Fortunately the low-pressure exhaust pipe was copper, and ran on an angle of about 45 degrees to the condenser, and therefore could stand being sprung.

The bolts on the guides were slackened and the cut-off was run out on the high-pressure link, allowing the high-pressure engine to do most of the work, and the steam reduced as soon as possible. The engine was kept turning over slowly in an attempt to keep the vessel headed into the sea.

All hands were called, and a short cargo boom, about 6 inches in diameter, was procured from on deck, which was cut for a shore from the after corner of the low-pressure cylinder to the deck above. The piece of the boom that was left was placed horizontally under the deck to wedge against, with the shore and the ends of the same blocked, to distribute the load along several of the deck beams and to protect the hatch combing around the engine-room skylight. With this arrangement the revolutions were gradually increased, but it soon became apparent that this rig would not do much good, as the working of the cylinder loosened the wedges, and there was too much spring in the deck beams to shore against at this point, where they had been cut for the engine-room skylight. A chain sling was next passed over the end of the low-pressure valve chest, which was cast on the cylinder, and with a 2-ton chain tackle a strain was taken from one of the large foundation bolts, the nut of which had been backed off enough to pass a short wire strap around it under the nut. As the chain tackle was led on an angle from the crack (as will be seen in the sketch) it stopped most of the lateral motion of the cylinder, and the engine was run at half speed, just fast enough, with the aid of a few staysails, to keep her hove to. By morning the weather had moderated, and the captain and chief held a consultation, and decided that as we were over 1,200 miles from the sound, and it was a little over 4,000 miles to our destination, the vessel having weathered as bad a storm as we were likely to encounter, it would be better to make more permanent repairs and continue on our course. The engine was run at a little less than half speed while the following repairs were made. One watch made the repairs while the other two stood watch and watch.

Two spare, wide steel bearer bars were found stowed in the fire room, cut and drilled, as shown in the sketch; the holes were drilled away from the crack, owing to the fact that the metal was very thin there, which was responsible for the break, evidently caused by the shifting of the core in casting the column. One hole was drilled ⅛ inch larger than the bolts in each end of the pieces, and the two corresponding holes drilled the same in the columns for temporary bolts to hold the pieces in place while the other holes were being drilled through the plates into the columns, to make sure the holes would be in line, and we would have no trouble entering the bolts. The pieces were set to center lines on the column and on the plates. The holes were next drilled in the top part of the column, a neat fit for ⅞-inch rough bolts finished by hand. Next the temporary bolts were loosened, and the pieces dropped down three thirty-seconds of an inch, being careful to keep the pieces on the center lines, and the temporary bolts again set up, and the holes drilled in the bottom part of the column. (In this way the holes in the column measured just three thirty-seconds more from center to center than the holes in the plates.) Next a hand-hole was cut in the back of the column, where the metal was thin, to put the bolts in place. The engine was then stopped, with the bolts all started in the holes, so that they could be instantly tapped into place; the side plates were heated in the furnace almost to a white heat (to elongate the plates the three thirty-seconds difference

* We pay for these articles.

from center to center between the holes in the plates and in the columns), and brought in with tongs and held in place with drift pins. The bolts were tapped into place, and the nuts held in socket wrenches screwed on and set up. When the side plates had cooled they brought the broken columns together, so that the break could hardly be found if it had not been for the cracked paint.

A large thin plate was then screwed on the back of the column with tap bolts, but not heated. It took a little over thirty-six hours to complete the repairs, during which time the engine was only stopped one hour, and that was while the hot plates were being put in place.

While it is true that columns do not break often, the same principle can be applied to other parts of the machinery in cases of emergency, where it is impossible with the tools on board to bring broken pieces together, or in tight places, where there is no room for a jack and nothing to jack against—a predicament so often found on board ship.

U. S. S. *Mackinac*. LT. J. W. GLOVER.

Supplementing Babbit Metal for Iron Castings in Breakdowns at Sea.

When a ship proceeds to sea there is hardly any indication of breakdowns; nevertheless every engineer should devote part of his "off watch" hours studying some method which would prove solid and substantial in effecting repairs to the different parts of his engines, should they become damaged or broken in any way while at sea. Most engineers would be at a loss at first in many instances, and as repairs must be started without a great deal of "head scratching" and wondering, I will relate as an instance the experience we had on board the steamship *Elmoro* immediately after leaving Valparaiso, Chile.

While in Valparaiso for a few days the general routine of port overhauling was being performed, along with expanding the rings of the high-pressure valve. Everything was finished in due time, and the day following we sailed. We had not proceeded very far when suddenly a sharp, cracking sound was heard in the high-pressure cylinder or thereabouts. The idea of proceeding was out of the question, so we stopped for an examination. On removing the high-pressure cylinder head and follower ring we found them all right. Next, the high-pressure valve bonnet was removed, and to our dismay the top ring of the piston valve was cracked in half a dozen places.

How were we going to make lasting repairs without working "compound"?

I must admit, after someone received the chief's "grammar" for expanding the ring too much and causing it to grip the walls of the chamber, we started a little of the aforesaid "head scratching." That did not better conditions any, so we eventually thought of casting a new ring, and this is how it was done.

Having several new babbited spare brasses and a small amount of scrap babbit, we decided to make a casting from this source. First, we made two wooden boxes, one with a bottom; one without, each 8 inches deep and about 16 inches square. While one man was making the boxes another was removing the broken ring. The pieces were matched together in their original positions, and a circular ring of wood 1½ inches thick with a large hole in the center was made to fit the interior circumference of the ring and then placed half way down in the ring. Each broken piece had one or two ⅛ inch holes drilled through it and slightly countersunk along a center line around the ring's circumference. Through these holes the pieces were nailed fast to the wooden ring inside. See Figs. 1 and 2.

Then a single thickness of canvas was glued around the ring, with a layer of wrapping paper glued outside to insure a smooth pattern. The canvas was placed there in order to make a casting slightly larger, allowing for finishing to proper size.

In the meanwhile some fire-clay was being prepared for the mold. This should only be damp, just sufficient to keep itself in form.

When everything was ready and the babbit had been melted out of the brasses, we placed in the bottom of one box enough clay to keep the pattern up to the middle line of the wooden ring and top edge of the box. Clay was packed around the ring (Fig. 3), both inside and out and smoothed

Fig.1
BROKEN RING

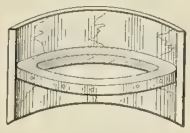


Fig.2
SECTIONAL VIEW SHOWING WOODEN RING INSIDE

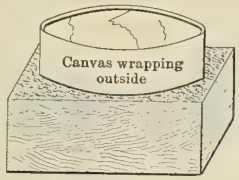


Fig.3
PATTERN IN BOTTOM BOX

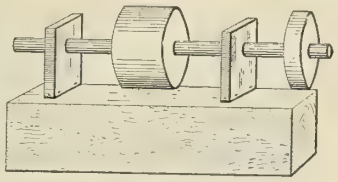


Fig.4
OUR "LATHE"
STEADY REST NOT SHOWN

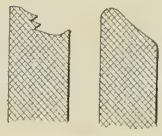


Fig.5

off even at the edge of the box. Over this surface a layer of paper was placed to prevent the clay in the top box from sticking to that in the bottom.

The other box was placed on top perfectly square with the bottom box and clay packed all around the ring up to the top. Now, the top box was tapped lightly all around its sides and lifted vertically away from the ring. Similar tapping on the bottom box loosened the ring sufficiently to be removed clear of the mold.

The impression made by the wood ring was neatly patched up so no metal would run into it. We then made a "gate" hole and vent in the top box and replaced it in its exact position again. We were then in readiness to cast. A few pounds of iron were placed across the upper box to prevent it from lifting when the metal reached the top in pouring.

After a new ring was cast and allowed to cool, the job of finishing it to a true circle was undertaken.

Filing it was unreliable, so more accurate means had to be thought of. Something in the form of a lathe was what we needed. Not having any aboard ship we had to make something that would answer in a crude way.

Two circular pieces of wood were cut to a moderate driving fit to the inside diameter of the babbit ring. These were then driven in each end like the heads of a common barrel. With a pair of hermaphrodite calipers we easily found the exact centers, and through these we bored 1½-inch holes to allow a wooden shaft to be shoved through. This wooden shaft was the chief's curtain pole and was perfectly straight and true.

We next constructed a base and journals. The base was a heavy block of wood about 16 inches square and 4 feet long. The journals were two plain pieces of wood 12 inches wide,

2 inches thick and 12 inches high. Each of these, of course, had a 1½-inch hole drilled through to receive the ring and shaft.

The journals were then slid on the shaft and securely nailed to the base. (Fig. 4.) A pulley 10 inches in diameter, 3 inches wide, was made also of wood and driven on one end of the shaft.

This makeshift lathe was carried around to the circulating engine, which was to supply us with power, and the pulley of our lathe placed in line with the shaft coupling on the engine. The lathe was secured to the floor plates by blocking the base with a few spare pin and journal brasses. A belt was made from a strip of canvas, sewed together at the ends.

The lathe was finished—now we needed a hand-trimming tool and a steady rest. The tool was made by breaking the end off a flat file and grinding it to the shape of Fig. 5. A steady rest was obtained in the shape of a piece of wood nailed from journal to journal, with its top edge on a line with the center of the shaft.

We were now ready to operate our "machine shop." The circulator was started slowly, and the act of turning down the ring was under way. Everything worked without a hitch and the ring was turned down to the exact size by hand in a short time.

When it was finished we removed it from its gear and screwed it on the valve casting and lowered it in the chamber. That finished our sea job, and we were in a few moments "full speed ahead" with the new ring working admirably.

Never did it give us the least trouble in any way, although it was examined at each port of call on the voyage. At the end of the run the wear was hardly noticeable, and we received congratulations from the superintendent engineer for our versatility in effecting such a good repair job.

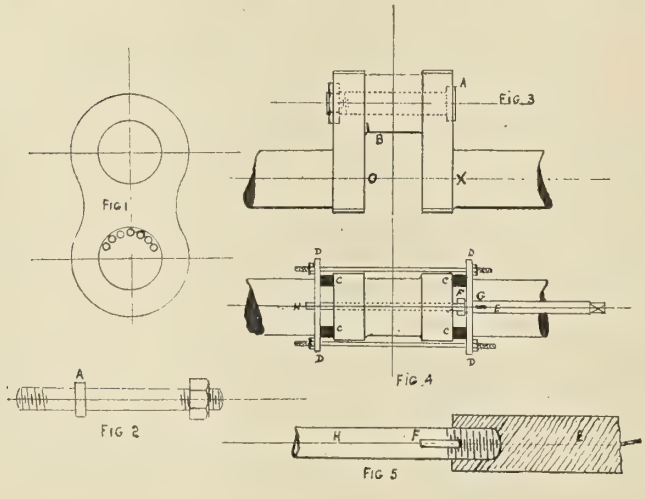
F. J. W.

Two Repairs to Crank Shafts.

MAKING GOOD A LOOSE WEB ON A BUILT CRANK SHAFT.

The crank shaft had been kept under observation, as a certain amount of slackness had been noticed between the shaft and the web. Later on, when at sea, knocking was heard, and it was located in the loose web. The repair was effected by drilling a number of holes round the end of the shaft, as shown in Fig. 1, and fitting taper screw pins, 1⅜ inches diameter, in each hole, and screwing them up as tightly as a key with a good leverage would accomplish. 1⅜ inches was the size of the largest screw tap on board.

Holes were drilled in the end of the shaft for about one-third of its circumference, as shown in the figure; the line of the holes being arranged to leave ½ inch of metal between them and the edge of the shaft. The holes were drilled 6 inches deep, and screwed with taper tap only. Each hole and pin was finished, and the pin screwed up as far as it would go before commencing the next. The line of screwed pins swelled the shaft in the neighborhood of the holes, and tightened the shaft in its web sufficiently to carry the ship to her home port without further trouble. When arrived in port a new shaft end was fitted to the existing web. The possibility of this being done, and so avoiding the expense of new shaft and web, had been foreseen when the method described above was adopted. If plugs had been fitted interlocking the shaft and web, apart from the fact of their liability to slack back when at work, a new shaft and a new web would have been required on arrival home.



A FLAW IN THE FILLET OF A CRANK PIN.

This was a repair executed on board a small steamer, carrying 100 nominal horsepower engines, running on a time charter up and down the West African coast. It was before the days of built-up crank shafts.

When at sea, a flaw was noticed in the fillet of the low-pressure crank pin, which though slight at first developed very rapidly, necessitating a very careful repair, or stoppage of the ship would have been necessary. The flaw extended over about one-third of the circumference of the after fillet and underneath the pin, "crank on top," as shown at *B* in Fig. 3. In the writer's experience, defects in crank shafts, whether solid or built up, usually occur at this point, and are mainly attributable to the faulty position of the thrust block. Instead of the thrust being taken up by the shaft bearing, the thrust block has to be adjusted, and a nip is thrown on the crank pin at the point *B* in Fig. 3, which usually results in a loose pin in a built-up crank shaft, or a flaw, as in this case, in a solid one. As the runs between the ports were not long the engines were kept running, but were well watched, while the engineers thought out the difficult problem of repair and got the necessary appliances ready.

The repair was effected by fitting a pin through the crank, as shown at *A* in Fig. 3, a spare main-bearing bolt with collar and nut, shown in Fig. 2, being employed for the purpose. Drills and ratchets were got already before the engine was stopped, and drilling was commenced from each end, a 1⅜-inch hole being drilled through both webs and crank pin, the holes meeting in the center. Colored labor being plentiful on the coast the holes were got out in good time.

After the holes were drilled the complete hole was bored by means of the arrangement shown in Fig. 4. A boring bar *E* was fitted with a pilot end *H* screwed into the boring bar, to save forging down and to keep the bar true. The slot for the cutting tool was arranged, as shown at *F* in Fig. 5, so that the body of the bar *E* took up the weight of the cutting. Another slot was cut at *G* in the boring bar, and a larger cutting tool was placed in it, which came into operation after the cutter *F*.

Fig. 4 shows the arrangement of the boring bar. The plates *D D* were used to support it, with the distance pieces *C C* long bolts, as shown, holding the whole thing together, and keeping the bar and the boring central with the pin. The hole was recessed at each end to receive the collar and nut, as shown in Fig. 3, and the nut was cut down for the recess.

When the boring was finished the crank was well warmed by means of a wood fire, the bolt tapped in with an anvil slung in ropes for the purpose, the bolt end outside of the collar being left on until the bolt was right in its place. The nut was then put on, hardened up, and the bolt end riveted over it. The ship completed her charter, and ran home with the repaired shaft. A new shaft had been sent out, but it was not necessary to use it.

John McCallum.

A Curious Deposit on the Inside of a Marine Boiler.

A very curious experience, which occurred on board a vessel running between the Indian ports and New York, may be of interest to other engineers, as showing the peculiar and unexpected troubles which sometimes give the mariner engineer and opportunity of deep thinking. After making one of these voyages the boilers were opened out for inspection and cleaning, and when the engineers got inside they were very much astonished to find the whole surface inside the boilers covered with a fine powder, which had the exact appearance of ordinary black lead. In spite of a lot of worry on the part of the staff no possible explanation of this trouble could at the time be thought of, but in order to prevent any further trouble of this description the men were put into the boilers, and the whole surface was scraped and cleaned as thoroughly as possible. When this had been done about half a ton of soda was put into each boiler, which was then filled with pure, fresh water; the fires were then lit, steam raised, and about 20 pounds pressure maintained on the boilers, the water being meanwhile kept in constant circulation by means of the independent feed pumps for a period of about twenty-four hours. The boilers were then allowed to stand and cool for two or three days before pumping them out, and when this had been done, and the boilers were opened out again, it was found that the black deposit had all been boiled off. The boilers were then washed clean and filled up again with fresh water, and the vessel got ready for the run of twenty-eight days.

The boat had not been long out to sea, however, before excitement began to be the order of the day, one after another the boiler tubes began to burst, and nearly every day it was necessary to put in either one or two new tubes. On one day the number rose to six. When the vessel reached port again the boilers were all opened out again, and a further trouble was discovered. The interior of the boilers was covered with red rust, or what is commonly known as bleeding, and all the scale that had been on had been cracked right away.

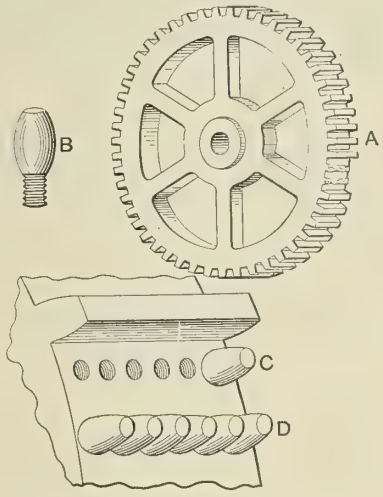
It was no easy matter to restore the boilers to their normal condition, and in order to get a thin scale on the boilers again it was necessary to use a very large quantity of lime, which was fed in with the feed water. After nearly twelve months this course of treatment secured a good scale on the boiler surfaces, and as soon as this was obtained the trouble ceased.

There is no definite solution to the mystery of the cause of formation of the original black deposit, but the only conclusion that can be arrived at is, that while the vessel was loading manganese ore the ship had been on the mud of the river, and a lot of the finer particles of the ore had, during previous repeated loadings, fallen into the water and settled on the bottom of the river. In this way a good deal of this ore was pumped into the boilers along with the feed water while the vessel was loading, and this had deposited and caked upon the internal surfaces of the boilers.

H. S. EMERSON.

A Barring Gear Breakdown.

It occasionally happens that owing to carelessness in putting the barring gear into mesh with the main engine, one or two of the teeth of the barring pinion get broken, as shown at *A* in the sketch. The first step in such an accident is to chip and file away the broken surface until it is level with the main portion of the rim in the casting. When this is the case a number of holes are drilled and tapped in the rim along the center line formerly occupied by each of the teeth which are to be repaired. Nearly every boat of any size has on board a small lathe, and it is then possible to turn from a rod of mild steel a series of studs similar to that shown at *B*. The contour of these studs should correspond accurately to the cross section of the tooth, and across the top of the stud when finished should be placed a saw-cut, to provide a hold for a screwdriver adjustment fixed to an ordinary brace. The shank of the stud should be screwed so as to form a fairly hard fit into the stud holes, and by the aid of the brace the stud should be tightened into position, as shown at *C* and *D*. After the studs are turned into the shape of the teeth very little dressing is required after they have been placed in position, in order to allow the pinion to run smoothly in gear with



SUBSTITUTION OF PINS FOR TEETH IN A BROKEN GEAR.

the engine, and if they are made of mild steel their tenacity and strength is nearly equal to that of the original cast teeth, and thus this forms a very good repair.

It will be seen that the only drawback to this arrangement is, that instead of a continuous bearing surface being presented to the engaging teeth, the wear takes place on a series of small curved surfaces, and the wear is therefore unduly great. Where plenty of time is available, or where the wheel can be sent off the ship, it is advisable to leave the surface of the studs rough, and to bring the teeth to shape after they have been put into position, either by means of chipping and filing, which in the case of a large wheel is rather a tedious matter, or if the job can be done on shore, to place the wheel in a shaping machine and take a series of cuts along the line of the studs, so working them to shape. MACHINIST.

Twin-Screw Yacht Miranda.

The largest steam yacht which has been built on the south coast of England was built at the Southampton works of Messrs. John I. Thornycroft & Company, Ltd., last summer, for Lord Leith of Fyvie; the contract for the hull and machinery being sublet to Messrs. Thornycroft by Messrs. Camper & Nicholsons, Ltd.

The vessel, which is called the *Miranda,* is built of steel, and was designed by Mr. Charles Nicholson, of Gosport. She is 220 feet in length over all, and 190 feet on the waterline. The breadth is 31 feet 10½ inches, and the contract 14 knots on a draft of 13 feet. The Thames yacht measurement is about 1,000 tons.

The machinery, also built by Messrs. Thornycroft, consists of two sets of triple-expansion surface-condensing engines, with cylinders 14½ inches, 23½ inches and 38 inches diameter by 24-inch stroke. The boiler installation comprises two boilers of the single-ended return type, working at a pressure of 180 pounds per square inch.

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Shipbuilding in the United States.

According to the annual report of the Commissioner of Navigation, the total tonnage of shipping constructed in the United States for the fiscal year ending June 30, 1909, was the smallest since 1898. The construction for 1908, which comprised 1,457 vessels, aggregating 614,216 gross tons, was the largest ever constructed. The decline, therefore, to 1,247 vessels of only 238,090 gross tons in 1909 is very marked, and indicates that shipbuilding during the past year has been practically at a standstill as compared with previous years. This sharp decline was, of course, not unexpected, on account of the general business depression throughout the world. Other countries suffered in this respect as well as the United States, for shipbuilding in the United Kingdom dropped from 1,580,000 tons in the calendar year 1907 to 914,000 tons in 1908.

Of the total tonnage constructed, 582 ships, aggregating 108,904 gross tons, were built on the Atlantic and Gulf coasts, while 174 ships, aggregating 100,402 gross tons, were built on the Great Lakes. One hundred and forty-one sailing vessels, with a total gross tonnage of 28,950, were constructed during the year, and 821 steamships, with a total gross tonnage of 148,208. No large vessels were built for ocean-going service during the year; in fact, only 31 vessels of over 1,000 gross tons were built, and these comprised only about 50 percent of the total tonnage. The largest of these was the Clyde liner *Mohawk,* of 4,623 gross tons, built at Philadelphia. This shows that the large shipyards on the coast were practically without merchant work during the year, and without naval work they would have been in severe straits. The only type of construction which reached anywhere near an encouraging figure was that included by steel ferryboats, steam dredges and river and bay steamers, all other forms showing a marked decrease, the most noticeable decrease being, of course, that of ocean steel steamers.

During the past few months shipbuilding has revived somewhat, and it is estimated that both in the United States and abroad the tonnage built during the current fiscal year will approach approximately the normal output. Encouraging as this appears, it should not be forgotten that the normal output of the shipyards on the Atlantic and Pacific coasts of the United States is ridiculously low as compared with that of the yards of other countries of similar importance. Nor is this condition of affairs likely to be bettered until steps are taken by the government toward the upbuilding of the American merchant marine in the foreign trade. As long as the deep-sea tonnage is neglected the shipping and shipbuilding industries cannot possibly provide the resources demanded by the naval strength and commercial importance of the nation.

Performance of the Battleship Delaware.

Last month we published a description of the battleships *Delaware* and *North Dakota,* and gave fairly complete details of the official trials of the *North Dakota.* Since then figures covering the trial performance of the *Delaware* have come to hand, and it is interesting to compare them with the results obtained with the *North Dakota.*

On the four-hour full-speed trial the speed of the *Delaware* was 21.563 knots; the indicated horsepower, 28,578; the coal consumption, 24.5 tons per hour; the steam consumption of the main engines per indicated horsepower per hour, 13.12 pounds, and the steam consumption for all purposes per indicated horsepower per hour, 14.56 pounds. On the twenty-four-hour trial at

19 knots the average speed was 19.225 knots; the indicated horsepower, 23,600; the steam consumption per indicated horsepower per hour of the main engines, 13.05 pounds, and the steam consumption per indicated horsepower per hour for all purposes, 14.5 pounds. For the full-power trial of the *North Dakota* the steam consumption of the main turbines per shaft-horsepower per hour was 13.6 pounds, and for all purposes, 13.96 pounds. On this trial, however, the *North Dakota* reached a somewhat higher speed than the *Delaware,* her average speed being 21.64 knots. For the twenty-four-hour trial at 19 knots her steam consumption per shaft-horsepower per hour for the main engines was 14.11 pounds, and for all purposes, 15.29 pounds.

It is, of course, impossible to draw any exact conclusions from this comparison, since we are dealing in one case with the indicated horsepower of reciprocating engines and in the other with shaft horsepower of turbines. More complete details of the trials will undoubtedly be made public by the Navy Department in the future; meanwhile, it is safe to conclude that the Navy Department is satisfied with the performance of turbine engines for battleships, since they are being adopted in all new construction.

Naval Reorganization.

Important reforms in the administration of the Navy Department have been inaugurated by the new Secretary of the Navy. These reforms affect first, the organization of the Navy Department itself; second, the administration of navy yards.

The changes in the organization of the Navy Department have been designed to overcome the defects of the old organization due to the lack of a branch dealing directly with the military use of the fleet and the lack of responsible expert advisers to aid the Secretary in reaching conclusions in case of disagreement between the co-ordinate branches of the department. On account of the growth of the navy and the increasing amount of business, the different bureau chiefs have been necessarily engrossed in the details of their own duties and, with the complexity and conflicting interests involved in the creation and maintenance of a modern fleet, they have at times failed to agree on matters where the field of each has overlapped. As the business of the department has grown beyond the personal co-ordinating power of the Secretary, it is necessary for him to have assistants in the different divisions to present matters of business for his verbal decision or for his signature. To effect the principal changes found necessary, it is intended to abolish the Bureau of Equipment and distribute its duties among the other bureaus. The other bureaus are continued in full effect. To fill the position of advisers to the Secretary the department has decided to detail four officers who are of recognized ability and specially fitted by experience in their particular fields, and who will be, so far as practicable, flag officers. These aids will have no supervisory or executive power or authority, and will act solely in an advisory capacity.

The reorganization in the administration of work at navy yards is in the nature of the extension and modification of the reforms inaugurated by the previous Secretary of the Navy. The principle underlying these previous reforms was consolidation, and this is to be carried out as far as possible under the present scheme of administration. The original consolidation scheme left the commandants of navy yards nominally in full control, but really without much supervision over the manager, who was the naval constructor. It created one pay-roll for the manufacturing department and put all labor under the manager. It also put the care of buildings and grounds and all civil engineering work under the manager. The direct and beneficial effect was to move machines and tools to more useful locations and reduce the number of shops employed for manufacturing and repair. The disadvantage, however, lay in the fact that the function of the officers in other bureaus than that of construction and repair was reduced nominally to that of inspectors. Thus, the equipment, ordnance and engineer officers, who were for the most part men of from twenty-five to thirty-five years' experience, were replaced by young assistants of comparatively few years' theoretical training, and, generally speaking, of little practical experience. It also deprived line officers of that practical shop and navy yard experience which they need to be able to maintain the vessels of the fleet in good condition without too frequent recourse to navy yards, and it placed upon the managers in most instances more work than they could properly be expected to perform. In the reorganization of the work the machinery and hull divisions are separated and the machinery division placed under the charge of the engineer officer. This division is logical, and follows the almost universal practice in the management of similar classes of work in manufacturing and repair establishments, and it also accords absolutely with the systems in successful operation in most private shipbuilding concerns and in the naval dockyards of England and Germany. The management of navy yards is again placed in the hands of the commandant or captain, and it is the intention that these officers shall be carefully selected and specially qualified by previous training and experience, and that the length of time which they hold office shall be sufficient to give them the opportunity to produce a continuous and efficient administration.

Doubtless for a time the management of the yards will not be as smooth or as efficient as it formerly was, since no new system can be inaugurated and worked out perfectly at the first trial. The principles underlying the reorganization are, however, excellent, and the changes should in the end prove beneficial.

Progress of Naval Vessels.

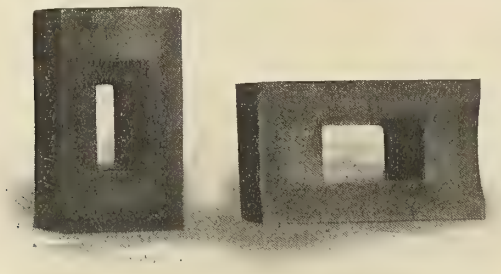
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Nov. 1.	Dec. 1.
BATTLESHIPS.					
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	97.4	98.0
North Dakota	20,000	21	Fore River Shipbuilding Co..	96.6	97.5
Florida	20,000	20¾	Navy Yord, New York.....	38.3	42.3
Utah	20,000	20¾	New York Shipbuilding Co..	50.0	54.3
Arkansas ...	26,000	20½	New York Shipbuilding Co..	1.0	3.2
Wyoming ..	26,000	20½	Wm. Cramp & Sons.....	0.0	1.7
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.....	99.4	100.0
Lamson	700	28	Wm. Cramp & Sons.....	92.8	94.8
Preston	700	28	New York Shipbuilding Co..	95.9	99.7
Paulding ...	742	29½	Bath Iron Works.....	46.1	53.5
Drayton	742	29½	Bath Iron Works.....	37.0	46.8
Roe	742	29½	Newp't News Shipbuilding Co.	66.4	68.8
Terry	742	29½	Newp't News Shipbuilding Co.	65.8	68.4
Perkins	742	29½	Fore River Shipbuilding Co..	59.3	64.0
Sterrett	742	29½	Fore River Shipbuilding Co..	58.1	62.6
McCall	742	29½	New York Shipbuilding Co..	34.2	37.5
Burrows	742	29½	New York Shipbuilding Co..	34.2	37.5
Warrington..	742	29½	Wm. Cramp & Sons.....	53.0	55.6
Mayrant	742	29½	Wm. Cramp & Sons.....	54.6	56.5
Monaghan ..	...	..	Newp't News Shipbuilding Co.	3.2	4.7
Trippe	...	..	Bath Iron Works.....	7.9	11.8
Walke	...	..	Fore River Shipbuilding Co..	5.2	7.9
Ammen	...	..	Fore River Shipbuilding Co..	8.2	10.4
Patterson ...	...	..	Wm. Cramp & Sons.....	3.4	5.1
SUBMARINE TORPEDO BOATS.					
Snapper	...	..	Fore River Shipbuilding Co..	99.3	99.3
Salmon	...	..	Fore River Shipbuilding Co..	87.0	87.2
Seal	...	..	Newp't News Shipbuilding Co.	28.2	30.8
Carp	...	..	Union Iron Works.....	16.0	27.4
Barracuda ..	...	..	Union Iron Works.....	16.1	27.5
Pickerel	...	..	The Moran Co.....	13.0	23.1
Skate	...	..	The Moran Co.....	13.1	23.1
Skipjack	...	..	Fore River Shipbuilding Co..	8.4	11.1
Sturgeon ...	...	..	Fore River Shipbuilding Co..	8.4	11.1
Tuna	...	..	Newp't News Shipbuilding Co.	7.7	9.9

ENGINEERING SPECIALTIES.

Vanadium Steel Dies for Hot Forging and Drawing Work.

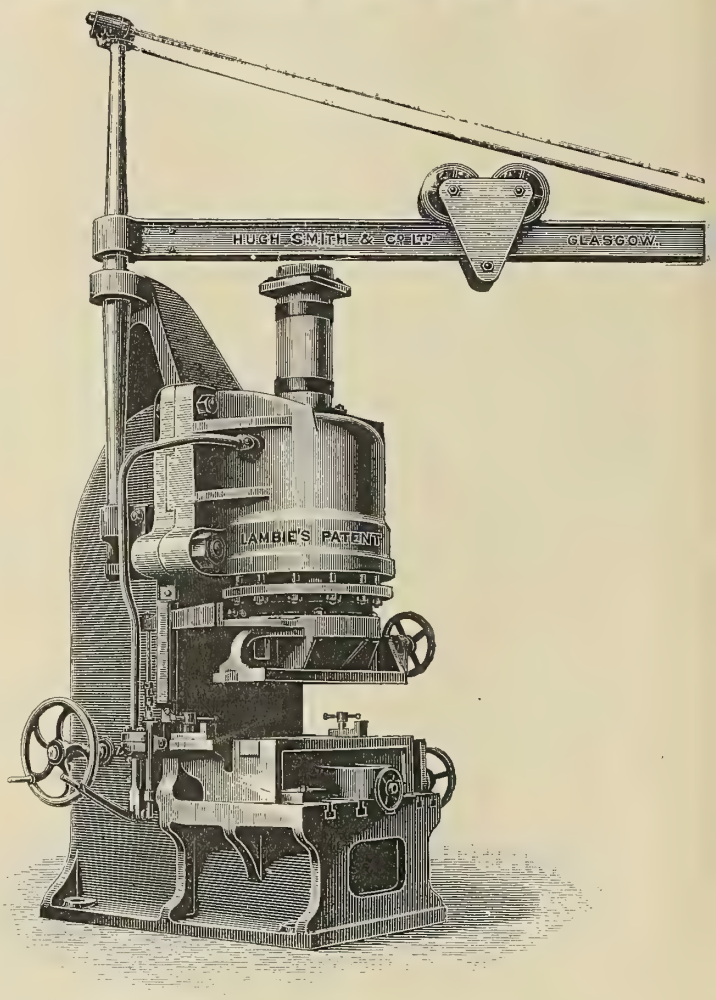
A customer of the Pennsylvania Forge Company, Philadelphia, Pa., was using carbon dies on very severe service for hot forging and drawing work. These dies were giving an average service of two days, and breaking from crystallization and other defects in the steel. They decided to try vanadium steel in the hope that the remarkable properties of



vanadium in retarding or eliminating crystallization would give the dies a longer period of usefulness; some vanadium steel was purchased from the Bethlehem Steel Company, and the dies shown in the illustration were made therefrom. We have been advised by the Pennsylvania Forge Company that the dies were used in the same manner, by the same man, on the same machine and for the same service as the carbon dies, and at the time of writing us had been in use for over four months; the illustration is made from a photograph of the dies at the time the letter was written.

"Lambie's" Patent Hydraulic Joggling Machine.

The illustration shows "Lambie's" patent combined hydraulic angle-bar and plate-joggling machine, manufactured by Hugh Smith & Company, Ltd., Possil Engine Works, Glasgow, for joggling angle-bars or bulb angles, as used in ships' frames, and also for joggling ships' deck plates to obviate the use of packing slips or liners. The machine is suitable for joggling the angles, bulb angles, or plates, without alteration or changing of dies. The die blocks are fitted with patent wedge arrangements for adjusting, so as to give the amount of joggle, either to the plates or angles, as may be required,

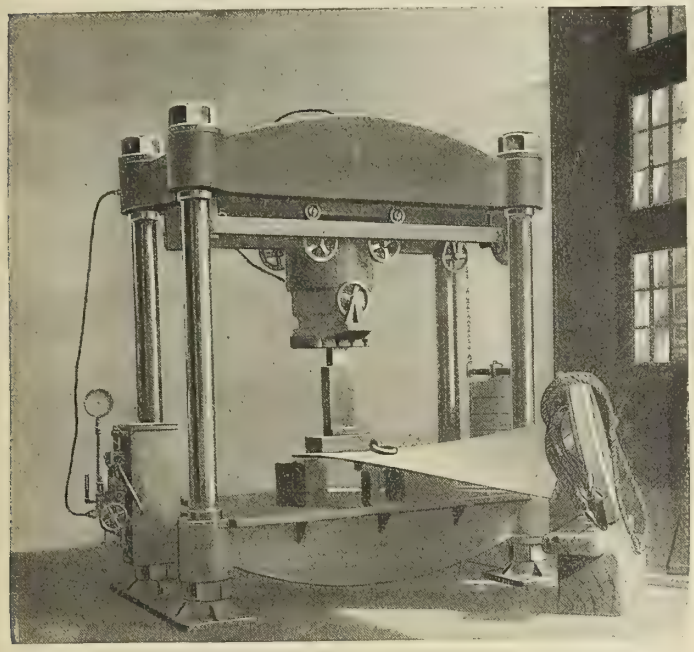


the die blocks being indicated and marked for the guidance of the workman. The cylinders and rams are made of suitable size to suit the water pressure available. The machine can also be adapted for punching manholes, or used for flanging plates and beveling angles. The saving in weight of hull effected by working on this system is claimed to be about 10 tons per 1,000 tons dead-weight capacity of vessel, which adds to the carrying capacity of the vessel. A considerable saving in workmanship is also effected.

Straightening Propeller Blades by Hydraulic Power.

Straightening propeller blades, which have become bent through contact with some solid object, is rather a trying job, because, usually, the force of the impact in a collision curls the metal up to something the shape of a wood shaving. The practice in straightening out such curves has been to block the bent part of the blade into a yoke with two stationary bearing points on the bottom platen, and apply a powerful pressure on top between these points by means of a hydraulic jack inverted from the upper platen of the yoke. If enough pressure could not be secured in this way, the blade was blocked with one stationary bearing underneath, and two hydraulic jacks on top, one on either side, forced the blade back to proper shape.

In the Brooklyn navy yard two 100-ton hydraulic jacks were used in this way, but the power was hardly sufficient for straightening the larger blades. To meet the demand for greater power, the straightening press shown in the illustration



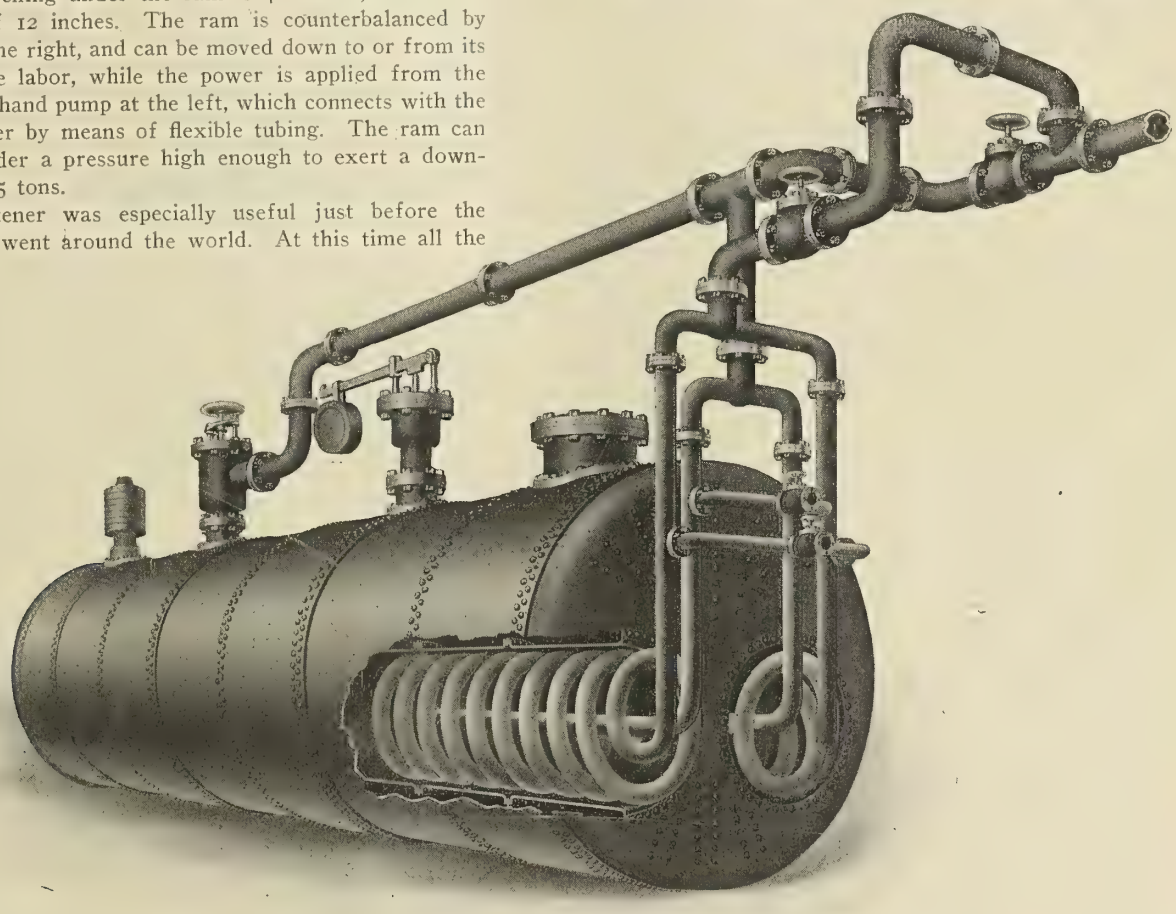
was designed and built by the Watson-Stillman Company, of New York. The platens are each 54 inches by 84 inches. The ram cylinder is mounted on a truck, which travels 2 feet either way from the center on tracks just below the upper platen. The vertical opening under the ram is 42 inches, and it has a movement of 12 inches. The ram is counterbalanced by the weights at the right, and can be moved down to or from its work with little labor, while the power is applied from the double-plunger hand pump at the left, which connects with the pressure cylinder by means of flexible tubing. The ram can be operated under a pressure high enough to exert a downward force of 5 tons.

This straightener was especially useful just before the American fleet went around the world. At this time all the bent propellers were replaced by new ones, and the bent blades were straightened. These were placed on board their respective ships and kept as spares in case of accident in a foreign port. The delay and expense thus prevented more than paid for the straighening press. This machine has frequently proven useful in shaft straightening, having enough power to bend a 14-inch shaft, cold, on bearings 6½ feet apart. In one instance a 16-inch propeller shaft was so badly bent at the beginning of the taper that the outer end where the blades were fastened was ¾ inch off center. This shaft was bent back into good alinement, where otherwise it would have been a loss.

As a general utility tool the machine is also used for such work as putting tires on the yard locomotive wheels, forcing pistons and cross-heads onto piston rods, putting in and taking out bushings, making compression tests, forcing steel spiders onto wrought pipe, in building large piston valves, etc. A hole 12 inches in diameter in the lower platen facilitates forcing work vertically.

The Steamcubator.

The Steamcubator, manufactured by the Steamcubator Engineering Company, London W. C., is an apparatus designed for attachment to boilers to protect the ordinary or saturated steam, developing it to the highest degree of quality and efficiency to which it is theoretically or practically possible for steam to attain. The water of saturation which the steam contains when leaving the boiler proper retards its velocity and conducts to rapid condensation, but when passed through the Steamcubator it is generated into active live steam of high temperature, thus producing not only a larger yield of true steam, but enormously increasing the velocity and expansive force of the whole. The absolute minimum tendency



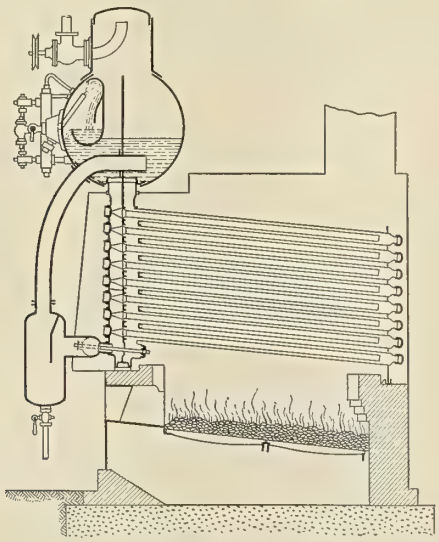
to condensation is secured. The Steamcubator, by reason of the fixing of the helix in the flue tubes of Lancashire, Cornish, and marine boilers, imparts to the gases a rifled or spiral motion, which increases their velocity, thereby aiding combustion by accelerated draft.

The deleterious effect of steam superheated by ordinary superheating apparatus is caused, not by the temperature to which the steam is raised, but by the method of attaining this temperature. This method results in part of the steam being decomposed into its original elements of oxygen and hydrogen. The free oxygen at once attacks and combines with the iron or steel with which it comes in contact, forming the neutral salt, oxide of iron, while the free hydrogen gas destroys, by volatilization or carbonization, the lubricating agents in the steam cylinders, and causes scoring and reeding. In the Steamcubator the steam is treated in substantial bulk or volume, and only gradually raised to a high temperature, retaining its original proportion of oxygen.

A fuel saving of 30 to 40 percent is claimed for this apparatus, and it is also claimed that the steaming capacity of boilers is increased by 50 percent.

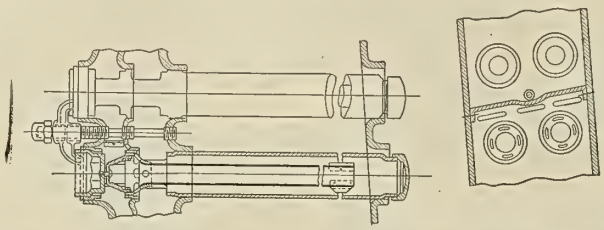
Improvements in the Niclausse Boiler.

Details have just been made public of important improvements in the Niclausse marine watertube boiler manufactured by J. & A. Niclausse, Paris, France. During the last two years it has been the policy of the manufacturers to eliminate all cast iron from the construction of the boilers, replacing it



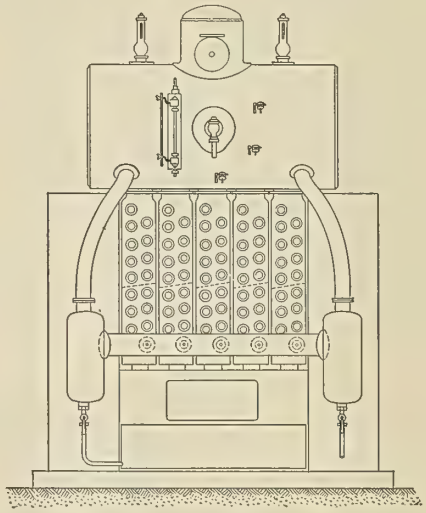
with steel. The headers, which formerly were made of malleable iron, now consist of rectangular steel tubes, which are formed without welding, and in which are flanged by means of powerful pressure the cones which receive the tubes. Also the lanterns, instead of being made separately, are cut from the tubes themselves. Improvements in the furnace include compressed air jets, which have been installed under the grates in order to secure better combustion and to avoid a reignation of the gases in the stack. A new arrangement has also been provided, by means of which the tubes can be cleaned without interrupting the generation of steam or lowering the pressure, but the most important improvement and the one which the manufacturers are having patented has for its object the bringing into the lower row of tubes; that is, those which are exposed to the highest temperatures, water which has been heated to a high temperature and cleansed of all the impurities which it originally contained.

This result has been secured by dividing the headers into two parts by means of a diaphragm, as is shown in the illustrations. The rows of tubes are also divided into two sections—the upper and the lower. The feed water enters directly, as in the old type of boiler, into the upper nest of tubes, where it is heated to a high temperature and deposits whatever impuirities it contains in these tubes, where no harm is done, since the tubes are not exposed directly to the flames. After the water has been heated and purified, it reascends to the steam drum and by means of two down-comers is led to the lower nest of tubes. Two baffles placed in the lower part of the down-comers prevent any impurities which might still



remain in the feed water from entering the lower tubes, where the evaporation is very rapid.

It is claimed that this method of circulating the water in the boiler elimminates the distortion and burning of tubes due to overheating, since there is no opportunity for deposits to form on the inner surfaces of the tubes. The principal claims made for the new arrangement are greater safety, increased circulation, less frequent cleaning, reduction in the expense of maintenance, and elimination of the necessity of replacing tubes.

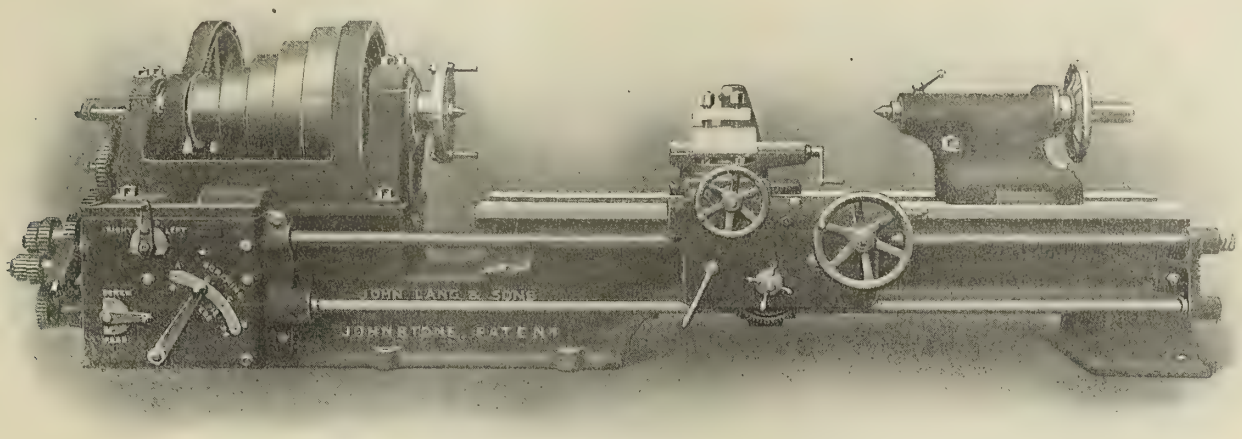


Experimental Tank Apparatus.

An important part of the work carried on by Kelso & Co., Glasgow, in addition to the building of ships' models as described on page 420 of our October, 1909, issue, is the construction of apparatus and equipment for experimental model towing tanks. This firm has built the entire equipment for nearly every important experimental model towing basin in existence, with the exception of that at Washington, D. C.

Sliding, Surfacing and Screw-Cutting Lathe.

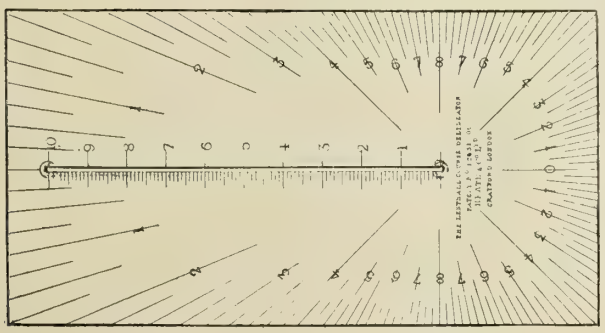
John Lang & Sons, lathe manufacturers, Johnstone, have placed on the market a lathe involving their latest developments in sliding, surfacing and screw cutting; the lathe being built for great power and rigidity, to allow engineers to obtain the advantages of high-speed steel. The bed, which is of Lang patent type, is 28 inches wide on the face and 25⅝ inches wide on the body. It can swing at gap 55 inches clear



of the screw and bed. The distance from the front face plate to the front of the gap is 17 inches. The lathe will admit 7 feet 5 inches between centers when the bed is 15 feet long. Standard feeds given by Lang's handle-feed motion are 1/6, 1/12, 1/18 and 1/24 inch in advance of the tool per revolution of spindle. Due to the patent screw cutting and feed motions it is impossible to have the screw and shaft revolving at one time; it is impossible to put the surfacing and sliding feeds into action at one time. Either the screw or shaft can be started or stopped or reversed while the lathe is running. There are four feeds both for sliding and surfacing, which may be changed while the the lathe is running; four screws of different pitches may be cut, any one of which may be had without stopping the lathe. These may be altered by changing gears, every alteration allowing of four different pitches being cut while the feeds for surfacing and sliding remain constant, and are not affected by the alteration of change gears. The approximate floor space required by the machine is 16 feet 7 inches by 7 feet, and the total finished weight is 162 cwt.

Lenthall's Patent Delineator.

The illustration shows an instrument useful to all in charge of vessels, and particularly to yachtsmen, fishermen and masters of coasters or other small vessels. With it it is claimed that all problems in dead reckoning navigation can be accurately solved without the use of books, tables or any other instruments. The instrument is made of transparent celluloid and is radially divided from a central point, *A*, into points, half points and quarter points of the compass, or, if desired, into degrees. A slit just wide enough to take the point of a pencil is cut from the central point, *A*, to a point near the outer edge of the instrument. The slit is marked with a scale divided into ten equal parts, and each division is again subdivided into ten equal parts. The divisions on the scale are numbered consecutively from 1 to 10, commencing with the first division from the central point of the instrument. The radial lines indicating the points of the compass are numbered consecutively from 1 to 8 and 8 to 0 on either side of the slit. In the case of the instrument divided into degrees the radial lines indicating every 10 degrees are numbered consecutively in tens from 10 to 90 and 90 to 0 on either side of the slit. In using the instrument it is advisable to work the problems out on special paper that is ruled with vertical parallel lines. This useful and novel instrument is manufactured by Heath & Company, Ltd., Crayford, London.



SULZER DIESEL MARINE ENGINE.

BY P. JACOBY.

Liquid fuels long held a secondary position among fuels used for the production of mechanical energy, due partly to the limited supply and partly to the lack of proper means for using them economically. Contrary to the general impression, now, however, the output of the world's oil fields is extensive, amounting to over 35,000,000 tons in 1907, and steadily increasing since then. The supply, therefore, is no longer such an obstacle to the use of liquid fuel as it formerly was. The means for its utilization in the production of energy have also been improved; one of the most characteristic agencies for this being the Diesel internal combustion engine.

It is only recently, however, that the Diesel engine has been adapted to marine work, since in order for any internal combustion engine of large power to be useful for marine work it must be reversible. The question of direct reversal in the Diesel engine has been carefully workd out by Messrs. Sulzer Brothers, Winterthur, Switzerland, and in 1906 a direct reversible Sulzer Diesel marine engine was produced.

The engine (Fig. 1) is single acting and works on the two-stroke principle as follows:

On the upward stroke of the piston, as in the four-stroke cycle, the compression of the air in the cylinder is affected to such a degree that the heat produced is sufficient to spontaneously ignite the fuel on the introduction of the latter into the cylinder. During the downward stroke of the piston the fuel is admitted in the form of a spray and is gradually burnt as it enters the cylinder. On completion of the expansion, large ports in the wall of the cylinder are uncovered by the piston, the scavenging air valves in the cylinder cover are then opened and the expanded combustion

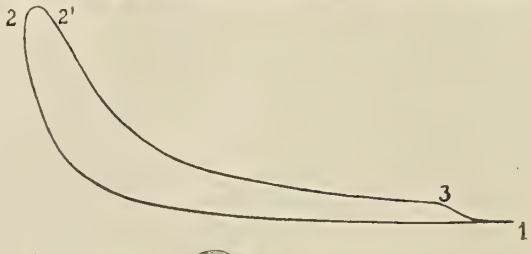
gases expelled by means of the scavenging air pump. The accompanying indicator diagram (Fig. 2) shows the method of working.

First stroke, compression and heating of air (curve1-2).

Second stroke, (working stroke) combustion (2-2′); expansion (2′-3); exhaust of combustion gases and introduction of pure air (3-1).

The engine is usually made with four cylinders, which not only insures a perfectly uniform turning moment, but enables the engine to be started with certainty, irrespective of the position of the crank. Besides the working cylinders the engine is supplied with an air pump for the highly compressed air for starting, reversing, and the injection of the fuel, and further, with a low-pressure scavenging air pump. Important accessories to the engine are the three steel vessels for the reception of the compressed air (for starting and injection purposes). The engine is of the enclosed type, but the various parts, such as cranks, bearings, pistons, etc., are readily accessible by means of removable doors.

from the fact that about 1,000,000 British thermal units of crude oil only require a space of 1 cubic foot, while 1,000,000 British thermal units of good hard coal would require about 1.35 cubic feet. With similar storage capacities, therefore, approximately 35 percent more energy can be carried. It is



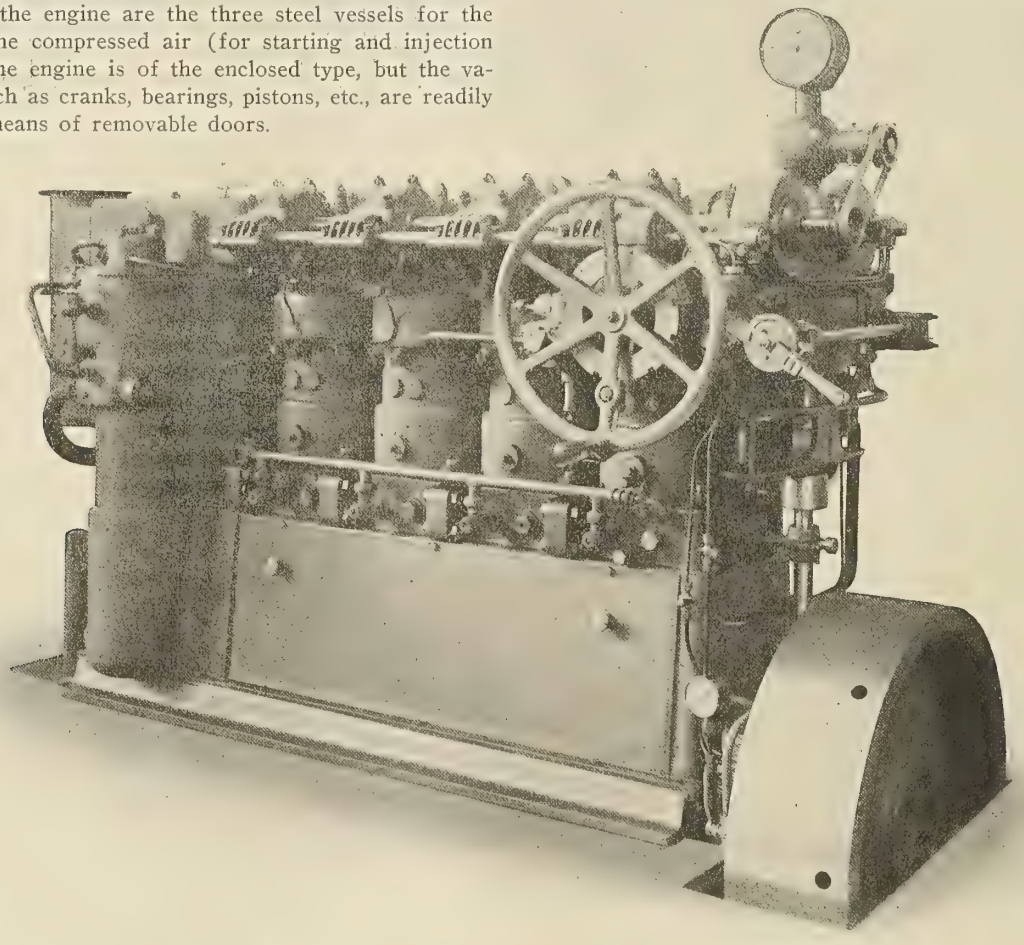


FIG. 1.

FIG. 2.

It is claimed that the engine can be reversed in a few seconds. When starting, the hand wheel, shown on the right of the engine in the illustration, is turned and admits compressed air into the cylinders. A further movement of the wheel puts the starting valve out of gear, at the same time opening the fuel valve so that the engine starts working. In the reverse manner the engine is stopped and reversed. The starting valves and fuel valves are operated by oscillating eccentric cams, the motion of which is determined by the motion of the reversing shaft according to the direction of the engine whether running or at rest.

The fuel, consisting of mineral oil residues (Mazout) and the cheap by- and intermediate products of oil refineries and gasworks, is easily stored in the double bottoms of ships and in the ballast tanks. It can be readily taken on board, either by means of pump and hose or by means of compressed air, so that no difficulty is experienced in transferring liquid fuel even on the high seas. In proportion to its high heating value, crude oil has a remarkably small bulk, as may be gathered

claimed that the Sulzer Diesel two-stroke engine consumes only about ½ pound of fuel per brake-horsepower-hour; consequently the radius of action of a ship thus equipped should be considerably greater than if provided with a steam plant.

General interest will be awakened by the results which have been obtained with a 150-horsepower engine recently supplied to the Steamship Company in Zurich. The company in question having a steamer which was useless for regular service on account of its slow speed determined to have it fitted with a more powerful engine. The speed of this particular steamer was hardly 8¾ miles per hour, whereas the present timetable demanded a speed of 11¼ miles per hour at least. The displacement remaining unaltered, this increase of about 30 percent in speed would have meant an increase of two and a half times in the output of the engine. The new plant was to fit into the space of the old one, and the weight was not to exceed the weight of the old plant. The working expenses, however, were to be cut down as much as possible. It was not difficult to foresee that the substitution of a

new steam plant for the old one would not have answered the purpose with any degree of certainty.

Preliminary investigations of this plant soon indicated that the conditions laid down, both as regards speed as well as economy, could be fulfilled by a Diesel engine. The Diesel engine was accordingly fitted in the early part of this year, and the steamer has done regular daily service since the end of July; the results of the trials exceeding all expectations, inasmuch as a speed of over 12 miles per hour is obtainable, while it is claimed the cost of fuel has been reduced to one-fourth. Compared with the old steam plant the output of the engine has been doubled. The amount of fuel carried is sufficient for the steamer to travel ten times the distance hitherto possible, and this at an increased rate of speed; at the same time a saving in weight of 35 percent results.

The trial trips, which were carried out by the steamship company, took place on Sept. 30, 1909. The trial course measured exactly 24 kilometres (14.9 miles). The fuel consumption was regulated by a decimal weighing apparatus, and it may be mentioned that the measurement of fuel as compared with that of coal is almost mathematically exact. The fuel used was Galician petroleum, the present price of which in Zurich is about 48/- ($11.50) per ton.

At a speed of 12½ miles per hour, the cost of fuel was 1½d. (3 cents) per mile; the cost of fuel per brake-horsepower-hour under similar conditions being 139d. ($2.78). The further working costs will also be considerably less than with the steam plant, as there is no boiler to maintain with its attendant expenses for cleaning, repairs and attention, and the engine room staff is reduced.

Announcement to users of BOILER COMPOUNDS

The undersigned organization was perfected to manufacture meritorious boiler compounds at prices lower than those heretofore prevailing. No other set of men in this country has as much experience in the treatment of boiler water. Individually our members have successfully filled the highest positions in compound manufacturing concerns whose names you know well. Collectively they have passed upon thousands of analyses and observed the workings of every efficient formula for LIQUID, POWDER or EXTRACT COMPOUNDS.

We are long past the experimenting necessary to assure the success of our product. We want business wholly and solely upon what our goods will do. The terms of our guarantee are unmistakable. We wish especially to interest men who have cut their eye teeth on the compound question, men who must be shown and who stick to a good thing when they get it. To such we offer a special price for a first order, a permanent saving, and the best boiler protection that money can buy.

Send sample of your Scale for analysis so that we can quote exact price.

GREEN, HOOK & CO., INC.

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SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

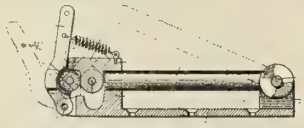
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

928,579. BOAT. ADOLPH E. APEL, OF ATLANTIC CITY, N. J.
Claim 2.—A motor boat consisting of a hull having a bow curved under and provided with a bottom compartment having side keels tapering in depth to nothing at the stern and the bottom of the boat between the side keels being made substantially flat transversely where the keels are deep and gradually curved upward in a transverse or athwartship direction adjacent to and at the stern and the highest point of such transverse curvature being at the transverse center of the boat, combined with means for delivering air into the compartment near the bow and forming a film of air between the bottom of the boat and the water, and whereby it leaves the bottom centrally of the boat at the stern. Two claims.

929,057. EXHAUST FOR MOTOR BOATS. JULIUS WM. WALTERS, OF GLENS FALLS, N. Y.
Claim 2.—A submerged exhaust outlet for motor boats provided with means responsive to movement of the vehicle to automatically control the direction of flow of the exhaust. Fourteen claims.

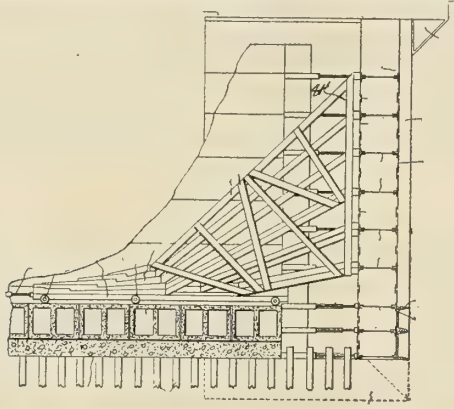
929,993. COAL-HANDLING APPARATUS. ALFRED CHAMBERS STEWART, OF READING, MASS., ASSIGNOR OF ONE-FOURTH TO AUSTIN H. ROBY, OF MALDEN, MASS., ONE-FOURTH TO CHARLES H. CUTTER, OF SOMERVILLE, MASS., AND ONE-FOURTH TO CHRISTIAN P. ANDERSEN, OF BOSTON, MASS.
Claim 1.—A coal handling apparatus comprising a hull, a fixed track composed of rails extending lengthwise of the hull, and elevated above the same, said rails being separated by an unobstructed space, a carrier adapted to run on said track and extending downwardly between the rails into said space, a movable track frame extending crosswise of the fixed track below the latter, and movable on the carrier crosswise of the hull, and a car movable on the said track frame. Seven claims.

931,122. RELEASING DEVICE. CHARLES HUNT, OF NEW YORK, N. Y., ASSIGNOR OF ONE-FOURTH TO JASON ROGERS, OF ESSEX FELLS, N. J.
Claim 1.—A boat provided at the ends with releasing devices, each comprising a frame attached to the boat, an arm pivoted on the frame



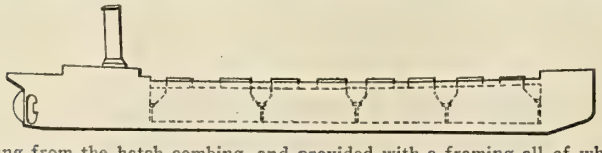
and adapted to receive a member of the boat-lowering device, a block pivoted on the frame, and engaging the free end of said arm, a lever for locking the block, and a spring connecting the end of said lever with the said block. Nine claims.

931,182. DRY-DOCK. LEONARD M. COX, OF BROOKLYN, N. Y.
Claim 1.—Apparatus for constructing dry docks and the like, comprising a coffer-dam open at the top, botom and rear and having hollow



front and side walls, power mechanism disposed between the dam and the work for advancing the dam, and means for maintaining water-tight joints between the side walls of the dam and finished portions of the dock. Twenty-four claims.

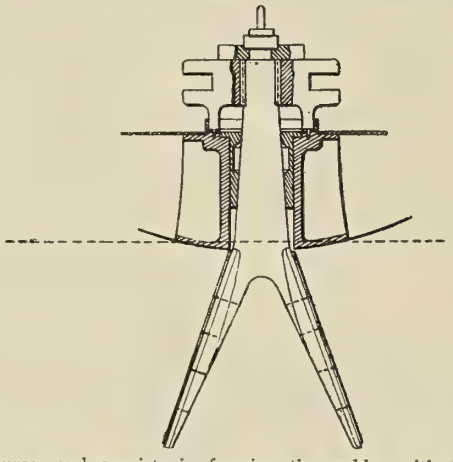
932,722. BALLAST TANK FOR SHIPS. GEORGE SIMPSON, OF QUINCY, MASS., ASSIGNOR TO FORE RIVER SHIP BUILDING COMPANY, A CORPORATION OF MASSACHUSETTS.
Claim 1.—A ballast tank for ships, located near the top of the cargo space of the ship and within the hull and having its inner wall which is exposed in said cargo space smooth and obstructionless, said wall being



hung from the hatch combing, and provided with a framing all of which is located wholly in the interior of the tank, said framing including braces fixed to said wall and adapted to be connected with the framing of the ship. Three claims.

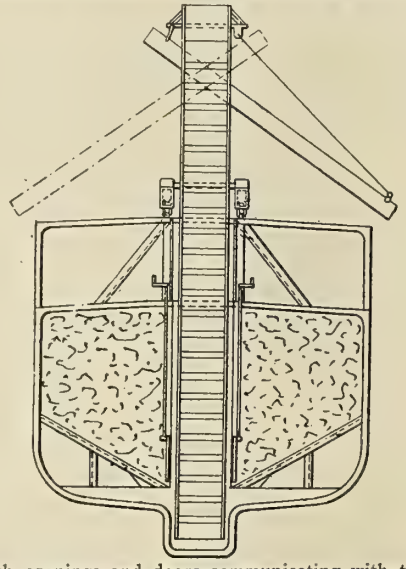
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

122. SRIPS' RUDDERS. J. WHITE & CO., LTD., OF EAST COWES, ISLE OF WIGHT, AND PETER HASTIE, OF THE SAME PLACE.
This invention has for its object to obviate the necessity for carrying helm to counteract the effect of the propeller race when running on a



straight course, and consists in forming the rudder with two flat or curved blades diverging downwardly from the stock and situating it relatively to the screw propeller in such a manner as to be above the zone of the water acted on thereby. For high-speed boats and for evenly distributing the effective pressure of the water over the whole of areas of the two blades they are provided with apertures.

861. CONSTRUCTION OF SHIPS OR LIGHTERS TO FACILITATE DISCHARGE OF CARGO IN BULK. G. E. HOLLAND, OF BRYN-Y-MOR, HOLYHEAD, ANGLESEY.
A ship or lighter for carrying cargo in bulk is constructed with a longitudinal central passage extending downwards into a box keel and



provided with openings and doors communicating with the hull of the vessel for the discharge of the cargo into such passage. Elevating apparatus is accommodated in the passage and mounted on a truck on rails supported on stanchions on each side of the passage.

5,581. POWER GAS PLANT FOR USE ON BOARD SHIP. T. H. OSWALD AND T. H. OSWALD, JR., BOTH OF LONDON, E. C.
According to this invention, the heat carried off from the engine cylinder or cylinders by the cooling water circulating through the cylinder jackets, as well as the waste heat of the gases exhausting from these cylinders, is utilized for the purpose of evaporating sea water and converting the same into fresh water for use in the process of generating suction or power gas.

19,586. PROPELLERS FOR SHIPS AND THE LIKE. C. FOX AND M. S. HOBBS, BOTH OF BOURNEMOUTH, HANTS.
According to this invention, the pitch of the screw is made less than, or at any rate not greater than the diameter of the blade. It is, however, not constant throughout its length and the leading part has preferably an increased pitch as compared with the rest. At the leading edge the blade is preferably made almost straight. Proceeding backward along the blade from this edge and along the side which presses against the water in forward driving, the face of the blade is made to gradually assume a concave form, the concavity being either greatest above the center part of the screw or even greatest at the rear end. The blade is attached to a straight piece of tubing, the diameter of this tubing being small, so that there is practically no boss to impede the action of the propeller.